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A RECORD OF PROGRESS RELATING TO AGRICULTURAL, MINERAL AND OTHER INDUSTRIES, WITH SPECIAL REFERENCE TO THE UTILISATION OF THE RAW MATERIALS OF THE DOMINIONS, INDIA AND THE COLONIES

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BULLETIN
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FOREWORD

GOOD NEWS FOR THE COLONIAL EMPIRE

We reproduce below with the approval of the Colonial Office and by courtesy of the British Broadcasting Corporation, a copy of a broadcast talk delivered by The Rt. Hon. Malcolm Macdonald, M.P., Secretary of State for the Colonies, entitled "Colonial Development." This address describes the character of the financial contributions which His Majesty's Government in the United Kingdom have decided to provide annually for assistance not only to the economic or material development of the Colonies, but also to their education and welfare services.

In this fateful war Britain's arms and fair reputation are sustained by the support of a united Colonial Empire. No fact should give us more pride and quiet confidence in the justice of our cause. The nations of the Empire which are self-governing, the Dominions, have sprung to our side, and it is deeply moving that the Canadians and the Australians and the New Zealanders are moving up towards the battle-line. But it is no less moving that the peoples of the Colonies are eager to share with us every hazard and danger of the War. They are not self-governing; they are still under our rule; they are small communities who might be excused if they shunned the fight. It is significant indeed that they, who have experience of us as rulers, recognise us instinctively as the champions of the liberty of small peoples.

It is difficult to generalise about the Colonial Empire, for its two-score and ten territories are widely distributed in every part of the world. And the peoples of the Colonies are as varied as the lands in which they live. Some of them are the proud inheritors of established civilisations, whose educated citizens are accustomed to high standards of material well-being and culture. But over vast stretches of the Empire the manner of life is much simpler, and in parts it is even yet in a primitive state. Remember that it

was only in the lifetime of some of you who are still living that David Livingstone made his pioneer journeys through Central Africa, discovering peoples in a state of as complete unsophistication as that of our own predecessors in Ancient Britain more than two thousand years ago.

And so the stage of political development of Colonial peoples differs from territory to territory. Under our guidance some of them have already progressed far along the road towards self-government. In one Colony, for instance, most of the Government departments are already under the control of responsible local ministers and popularly-elected local legislators ; and in many of the dependencies legislatures have sprung up which wield greater or lesser power. At the other end of the Colonial scale there are countries whose inhabitants have little capacity to look after their own affairs ; where the rule of Downing Street is still almost absolute. But the main purpose of our policy even amongst the most backward races, is to train the Colonial peoples to stand always a little more securely on their own feet, so that there is a steady development of freedom amongst all His Majesty's subjects in whatever part of the world they may live.

In the meantime, we are the trustees for their well-being. You and I are responsible for their good government. I think we must follow two principles : first, preserve and encourage everything that is good in the different ways of life and beliefs of each tribe or community or national people in the Colonial Empire, so that they remain their own characteristic selves and can make their own particular contributions to the varied story of mankind. Second, introduce in appropriate measure into every Colony what is best in the thought and practice of our Western civilisation, which has made so many discoveries that can help to make life fuller and more enjoyable for all men.

But the spread of an administration which is enlightened, and of up-to-date health and medical and education services, amongst the widely and often sparsely scattered population of the Colonies is a slow process. For one thing, the provision of such services is costly. And there we come up against one of the most obstinate problems of Colonial Development. Again I would warn you, it is not easy to generalise ; conditions vary so much from Colony to Colony. Nature has blessed these lands very unequally. Some of them are the owners of rich minerals, like oil, or tin, or copper or gold ; and the sale of these and some other highly-prized Colonial products has brought a goodly measure of wealth to these particular communities. Their governments dispense comparatively large revenues. But these are a minority of Colonial territories. Most of them possess no mineral wealth, nor are they endowed with that other present source of abundant material well-being, great manufacturing industries. Most Colonies are agricultural lands, under whose tropical or semi-tropical sun grow sugar and cocoa, citrus

fruits and spices, coconuts and oil seeds, tea and coffee and many other exotic foodstuffs, which may be essential to the welfare of mankind, but have ceased for a long time past to make fortunes for their producers.

The general slump in the prices of these things has had a most crippling effect on the revenues of Colonial Governments; and so their capacity to provide good service in every department has been limited. Though the Colonies are eager to support themselves to the maximum possible degree by their own efforts, most of them cannot, at present at any rate, make sufficient progress without financial as well as other assistance from outside.

It is part of the duties of our trusteeship to provide that help. For many years past this principle has been recognised. The British taxpayer has long been ministering to the well-being of his Colonial fellow-citizens by contributing towards essential schemes of capital development, towards important surveys and research work, towards the establishment of enlightened agricultural and other services which shall build up the economic strength of the Colonies, and enable them ultimately to support from their own resources all the necessary services of good government. That—self-sufficiency—is the ultimate goal of our assistance.

Yesterday, despite the other great demands made upon us in the stress of war, the Government announced a further extension of this policy of assistance to the Colonies and the Protectorates and the Mandated Territories for whose administration we are responsible. Let me summarise briefly the main new points of advance. I would mention three features.

First, in place of a Colonial Development Fund of a maximum of one million pounds a year, we are to make provision for assistance towards Colonial research, development and welfare up to five and a half million pounds a year. This sum is assured for at least ten years ahead. If as a result of experience this scale of expenditure proves inadequate, it will be open to Parliament to increase it further. But you will realise that the expenditure of five and a half million pounds a year in the Colonies will be equivalent to a much larger expenditure in, say, this country, because general costs in the Colonies are very much lower than they are here.

The second point to which I would draw your attention is this: hitherto, under the terms of the Colonial Development Act, we have given financial assistance only to schemes which were strictly concerned with the economic or material development of the Colonies. Thus, education (apart from technical education) was beyond the range of our help. It is true that occasionally we made a grant towards some special educational object, as we did when we gave one hundred thousand pounds last year towards the endowment fund of what will become a University College in East Africa. But apart from that, educational opportunities in the Colonies have grown only according to the financial means of the

local governments, which, especially in times of depression, were sometimes sparse. But under the Government's new proposals announced yesterday we shall widen the whole field of our help and give regular aid to the education and welfare services of the Colonies, which should be the greatest contribution of all to their peoples' emancipation.

Third, but not least, we are to sweep away another limitation on our power to help. Hitherto, under the Colonial Development Act, we have only been able to give assistance to the capital cost of development schemes. We could contribute to the building of research stations or hospitals or improved transport systems, and so on. But we could not make any payment at all to the running costs of these works afterwards. And so, if it appeared that the Colonial Government concerned would not be able to afford to pay those running costs, then the hospitals or the roads or the other schemes never came into being at all. In fact, it has been a principle of Colonial policy up to now, that each Colony should be a self-supporting unit, that its people should have only those services which, whether it were rich or poor, it could afford to maintain out of its own resources. Now that old principle is to go; and under the Government's new proposals we shall be able to assist Colonial Governments not only in the initial establishment but also in the more prolonged upkeep of any of those services which are needed in these days for the proper welfare of the peoples of the Colonies.

And so yesterday the British people took another long step forward in the accomplishment of their Imperial policy. In no spirit of boastfulness, but with feelings of some pride, we can look back on the record of the past. In our own lifetime there has been a remarkable climax to British Imperial achievement; five of the old Colonies have grown to full nationhood, and the Empire is transformed into a Commonwealth of Free Nations. The Dominions do not need any longer any guidance. But our duty remains to the Colonial peoples. That very achievement of complete freedom by the Dominions testifies to the fact that British Imperial genius is not spent; it is indeed at the zenith of its powers. Let us devote those powers to the steady achievement of greater well-being and happiness and freedom also amongst the sixty million citizens of the Colonial Empire.

MALCOLM MACDONALD,
Secretary of State for the Colonies.

21 *February* 1940.

PLANT AND ANIMAL PRODUCTS

ARTICLE

THE TUNG OIL INDUSTRY OF THE UNITED STATES

Report of an Inquiry carried out in Florida, Louisiana and Mississippi by M. Ashby, Ph.D., D.I.C., A.R.C.S., Assistant, Plant and Animal Products Department, Imperial Institute

During the months of May to October 1939 the writer was attached to the inquiry staff of the British Colonial Hall at the New York World's Fair. It was suggested by Sir Frank Stockdale, K.C.M.G., C.B.E., Agricultural Adviser to the Secretary of State for the Colonies and Chairman of the Advisory Council, Plant and Animal Products Department, Imperial Institute, that in view of the work of the Imperial Institute in developing tung oil production in British overseas countries the opportunity should be taken of making a study on the spot of the American tung oil industry. Through the courtesy of the Colonial Empire Marketing Board, funds were provided to enable a tour to be made of the tung growing regions of the Gulf States and the assistance thus rendered is gratefully acknowledged. The information gathered in the course of this tour, as well as the results of preliminary inquiries made in Washington and New York are incorporated in the following report.

General Outline of Inquiry

It may be of some assistance first to summarise the steps that were taken to gather the information here presented.

(i) *Visit to Washington.*—This was made for the purpose of seeing Dr. H. A. Gardner of the Institute of Paint and Varnish Research and Mr. C. C. Concannon, Chief of the Chemical Division, Bureau of Foreign and Domestic Commerce.

Dr. Gardner told me something of the American industry and gave me a detailed scheme for my visit to the Southern States recommending me to proceed with it as soon as possible before the season became too far advanced. He gave me letters of introduction to several people who he suggested that I should visit. On the trade aspects he explained the position as regards supplies from China and furnished me with the names of the principal American firms importing the oil in New York and elsewhere.

Finally, Dr. Gardner gave me a sample of Florida oil, and some of the literature which the Institute of Paint and Varnish Research has published on the industry.

Mr. Concannon gave me an outline of the present position of the industry and referred me to Mr. E. C. Wood (also of the Chemical Division) who is now chiefly concerned with the commercial and market aspects of the industry. Mr. Wood supplied me with some of the tung oil literature put out by the Department.

I understood that, while the domestic production of tung oil in the United States has so far been under the care of the Department of Commerce, it has now reached a stage when the Department of Agriculture has largely taken over the work.

(ii) *Visits to United States Department of Commerce in New York and to the principal firms in New York importing the oil.*—I was able to see the Department's files on the industry and to consult certain literature that is now out of print.

Later, I had interviews with representatives of the principal importing firms to discuss the position of the trade, and also called on the United States Customs Authorities in order to obtain information regarding the sampling practice.

(iii) *Visit to the tung-growing areas in the Gulf States.*—This took place during the latter half of October, which proved to be an ideal time of year. The foliage was still on the trees so that it was possible to form a good idea of their appearance and growth and to see the variations in leaf-form and the effects of such troubles as "bronzing" and bad soil drainage. At the same time the fruits were fully matured and just beginning to fall. The cover-crops were mostly just at the seeding stage.

Two days were spent at Gainesville when the groves of the China-Tung Oil Company (Mr. H. W. Bennett), the Alachua Tung Oil Company and a number of smaller concerns were visited. I was also taken over the two mills in the district, at Alachua and at Brooker. Before leaving I called at Gainesville University, where Mr. R. D. Dickey explained to me the tung oil work in which his Department has been engaged and took me round the University's experimental farm. During the course of my short stay in Gainesville I met Mr. Rolf K. Buckley, who is in charge of the Alachua Tung Oil Company's groves, Mr. H. W. Bennett of the China-Tung Oil Company, Mr. B. F. Williamson of the General Tung Oil Corporation, and Mr. R. D. Dickey and Mr. G. H. Blackmon who are working on tung problems at the University of Florida. Unfortunately there was no opportunity to see Dr. Lagassy and Dr. Sell who are also stationed at the University in connection with the Department of Agriculture tung research programme.

Leaving Gainesville, Mr. Dickey took me to see the extensive plantations around Lamont in North West Florida. It was fortunate indeed to have an opportunity of seeing these groves, which are regarded as among the finest in the country.

The remainder of the time was spent at Bogalusa, Louisiana, where the United States Department of Agriculture Tung Oil Investigation work is centred. Dr. G. F. Potter, who is in charge of the horticultural and botanical work, showed me over the laboratories and the experimental farm and spent three days taking me round to see the principal groves and mills in Louisiana and Mississippi. I also met Col. D. T. Cushing and Mr. Lamont Rowlands, both owners of large tung plantations, and certain other members of the staff of the Department of Agriculture Tung Oil Investigation Laboratories.

Throughout the whole of the visit to the tung-growing areas I received willing help and co-operation from all I met, but special thanks are due to Mr. Buckley, Mr. Dickey and Dr. Potter for the considerable trouble to which they went to assist me.

Tung Oil Production in the United States

(a) *Region of Cultivation*

While minor trials with growing the tung tree were made in America as long as thirty years ago, it is only within the last fifteen years that any commercial plantings were attempted, and all the large-scale plantations have arisen since 1930. From that year onwards the area under the crop has increased rapidly until to-day it is estimated that some 175,000 acres are planted with tung. It must be borne in mind, however, that many of the earlier groves were planted without proper knowledge of the tree's requirements, with the result that almost one-half of the present total acreage is probably unfit for profitable cultivation of the crop, and considerable areas have already been abandoned. New and extensive groves are still being laid down on suitable land and it seems likely that, as results are obtained in the work undertaken by the Department of Agriculture to improve stocks of planting material and tackle other problems confronting the planter, there will be very material increases of tung acreage in the future.

The region of the United States where the climate is suited to the growing of tung oil is restricted to a narrow coastal belt around the Gulf of Mexico taking in the southern part of the states of Texas, Louisiana, Mississippi, Alabama and Georgia, and a large part of Florida. North of this belt the frost-free period is not sufficiently long for the trees to grow successfully, while to the west the rainfall is inadequate. The earliest plantings of any size were in Northern Central Florida around Gainesville. Some new planting is going on in this district now, but greater development is to be expected in the North-Western part of the State at Lamont, near Tallahassee, where the soil appears to be richer. There is a considerable number of smaller groves in Alabama and Georgia, but few large enterprises. Mississippi has the largest tung acreage of any state, now approaching 100,000 acres and mostly in the form

of very extensive plantations. There is one alone, belonging to Mr. L. O. Crosby, which covers nearly 30,000 acres. Considerable areas of new plantings were seen in this state. In Louisiana, again, planting is mostly on a large scale, and the acreage is being increased. The groves of the Louisiana Tung Corporation alone occupy 17,000 acres and a further area of 25,000 acres is being planted. The acreage under the crop in Texas is not very extensive as the climate is on the dry side, though I understood that some new plantings are being made.

(*b*) *Species Grown*

The species of tung tree cultivated in the United States is *Aleurites fordii* Hemsl. (Plate IV, fig. 1).

A. montana (Lour.) Wils. appears to grow reasonably well in the Everglades region in Southern Florida, even on poor soils, but has not so far been tried on a commercial scale. Further north the winters and the spring frosts are too severe for this species, though it is interesting to note that a grafted branch borne on a tree of *A. fordii* in the grounds of the Florida University at Gainesville has made good growth and fruits regularly. In general it has been found that the seeds of *A. montana* show very poor germination, though one lot obtained from Burma proved to be good in this respect. Once germinated, there has been difficulty in establishing the seedlings even in the greenhouse, for although the shoots grow vigorously the root development is very poor indeed—after some weeks' growth in well-drained sand the appearance of the roots is exactly as if the plants had been waterlogged. It has been the experience in Florida that if this period of weak root development can be passed successfully and the plants become established, they make rapid progress where they are not liable to frost damage.

There were one or two seedlings of *Aleurites trisperma* Blanco growing in the greenhouses at the University in Gainesville, and I understood that a few isolated trees of this species are to be found growing out in the open in Southern Florida.

(*c*) *Soil Conditions*

As already mentioned, the species in cultivation in the United States is *A. fordii*. It may, therefore, be assumed that unless otherwise stated the details given in this and the following sections of the report refer to this species in particular, though in many cases they will doubtless have bearing on other species as well.

The soils all along this Gulf Coast belt are of a light sandy character. Geologically they may be classed as recent deposits not consolidated into sandstone, and a number of different series are distinguished. The series on which most of the tung is grown are the Norfolk, Orangeburg, Greenville, Ruston, Susquehanna,

Fellowship, Hernando, and Gainesville. Some further particulars of these different soil series may be found in publications of the University of Florida Agricultural Experiment Station [5, 6], and it is considered unnecessary to deal with them in detail here. Suffice it to say that they range from almost pure light sand to red sandy loams, and are of an acid nature, most samples having a *p*H value of between 5½ and 5. Soils of the Orangeburg series have given the most satisfactory results with a minimum application of fertiliser, being relatively rich sandy loams of a reddish colour. The groves of Messrs. Chase and Company at Lamont, Florida, are on soil of this type, and provide good evidence of its suitability for tung cultivation.

The natural vegetation on these soils is mostly rather poor pine forest (principally *Pinus palustris*, longleaf pine, and in Florida also *P. caribæa*, slash pine). Areas of oak scrub occur in Mississippi and Louisiana, particularly on the higher ground. For the most part it is not considered good agricultural land though in certain localities the soil is more productive: cotton, maize, satsumas, pecans, groundnuts and certain truck crops are those principally grown. Some of the tung plantations are on land previously cultivated, as, for example, Messrs. Chase and Company's groves at Lamont which are on the site of a formerly productive cotton plantation.

The above gives some idea of the general characters of the soils on which tung is grown. Local variations are frequent and often quite considerable, even within a single plantation. Such variations introduce difficulties in the economic application of fertiliser and result in uneven drainage.

As may be expected with light soils of the general type described, leaching is very heavy and pan formation not infrequent, resulting in shallow soils. The latter difficulty is overcome by hard-pan breakers drawn by heavy tractors (usually 60 h.p.).

In Florida the soil is underlaid, usually at considerable depth, with phosphatic limestone, and where outcrops of this rock occur tung trees will not grow successfully. This calciphobe tendency of tung trees is well known. Layers of clay also occur commonly at varying depths, and are of great importance as the roots of tung are highly susceptible to waterlogging even for very short periods. It is said that twenty-four hours' "wet feet" is sufficient to kill a tree, and very much less than this may cause severe damage. A large proportion of the failures among the earlier tung plantations may be put down to the fact that the vital importance of good drainage was not properly appreciated. Trees planted in badly drained soils appeared to be growing well until the roots reached the water table, but after that no further progress was made. The first indication of damage of this kind is a discolouration of the leaves to orange or red which shows from the middle of the growing season onwards. The appearance differs somewhat from the usual

autumn tints of the leaves. Even mild cases have a decided effect on growth, and one commonly sees a complete gradation of stunted trees where planting has gone too low in a local hollow. In parts of Florida the drainage is bad on the tops of the undulations, owing to pan formation or water-bearing strata, making them totally unfit for tung cultivation.

The effect of good drainage on the growth of the trees is well shown by an experiment carried out on Mr. Bennett's groves at Gainesville (China-Tung Oil Company). The natural drainage of the ground is by no means bad, and the plantation is in good condition. In one small plot, however, proper tile drainage has been laid down, a procedure far too expensive for general use, and a very marked increase in growth of the trees is noticeable.

(*d*) *Climate and Topography*

As already mentioned, the land suitable for growing tung in the United States is restricted to a narrow belt, on an average less than 100 miles wide, running round the coast of the Gulf of Mexico. This limitation is one of climate—rainfall and temperature being the principal factors concerned.

To the West the belt comes to an end just beyond the Mississippi Valley. Here rainfall is the limiting factor. The average annual rainfall at the western limit is about 50 in., but it is the distribution of this that is most important. Less than 30 per cent. of the total 50 in., falls in the summer months of June, July and August, as against 30 to 45 per cent. of the higher total precipitation in the eastern part of the belt. Cultivation trials that have been carried out west of Texas to California showed that the trees cannot withstand the prolonged periods of drought, while the return on the crop is not sufficiently high to warrant the expense of irrigation.

In general it may be said that a rainfall of between 50 and 60 in. is desirable for good growth of the trees under the conditions obtaining in the Gulf States. This should be well distributed throughout the year, particularly during the growing season. It is of interest that in Mississippi and Louisiana there is commonly a dry period of five or six weeks, beginning at the end of September and the trees appear to stand this fairly well.

The importance of the temperature factor cannot be overemphasised, as the success of the whole industry is threatened by frost damage. The species grown (*A. fordii*) requires a well-marked winter season to induce proper dormancy, and on this account it will not succeed in Southern Florida where the winter is too warm. Experiments have shown that if the trees' annual rhythm is upset by growing them in a climate lacking the proper seasonal variation they tend to lose their leaves three or four times in a year, while flowering becomes sporadic and the fruits set only occasionally. It is possible that *A. montana*, which requires a

warmer climate altogether, might succeed in Southern Florida. Individual trees appear to do well there, but so far no large-scale trials have been undertaken.

The northern margin of the tung belt is determined by the severity and time of occurrence of frosts and it is possible that by means of selection and breeding hardier stock may be developed, making it possible to extend the belt northwards. However, the frequent and extensive frost damage occurring within the belt has first to be overcome.

When completely dormant, mature trees are not injured by temperatures below 20° F. and old trees have been known to withstand 10° F. It should be pointed out that such frosts are only of short duration, the day temperature usually rising well above freezing. After a warm spell in the early winter, trees may be injured by a sudden severe frost, before they have become completely dormant. In this case the buds may be damaged and frost-cracks caused in the bark. The latter do not appear to do any lasting harm owing to the tung tree's extraordinary regenerative power. Young trees up to their third year are liable to frost damage and may sometimes be killed back nearly to the ground. In such cases they are cut back to within a few inches of ground level and grow up again vigorously in the following season.

By far the most serious problem is that presented by the spring frosts occurring in late March and early or middle April, which injure the blossom, bringing about very serious losses in the yield of fruits. Such injurious frosts do not come every year, but records show that large proportions of the crop were lost through this cause in 1933, 1935, 1937 and 1939. Much of the country on which tung is grown is just on the borderline with respect to frost damage and it is for this reason that the site of the grove becomes important. Trees in a slightly more favourable position (e.g. a few feet higher up the hill) will escape, while any in a hollow forming a " frost-hole " will suffer badly. These local differences in frost damage in the groves are very striking indeed and could be well observed this year as nearly all the areas had been affected.

As far as topography is concerned it may be said that the whole of the coastal belt is very low-lying and most of the tung land is between 100 and 150 ft. in altitude, sometimes slightly higher. In the newer groves the factor of air-drainage has been taken into account in selecting the sites. The new 25,000 acre grove now being laid down by the Louisiana Tung Corporation (owned by Messrs. Bowring, Jones and Tidy of London) near Bogalusa appears to be very well chosen in this respect.

There are certain differences in climate between the area of Mississippi and Louisiana around New Orleans and the parts of Florida where tung is grown. The most important is that the frosts in the Western area tend to be more severe. This, however, is offset by the fact that there is not the warm spell that often

occurs in Florida in late winter and early spring, bringing about premature development of the buds and making them more susceptible to late frosts. As already mentioned, the autumn droughts are generally more severe in the West than in Florida.

(*e*) *Cultivation Practice*

A considerable body of information is available in published form on the cultivation practice on tung estates in America [1, 5, 6, 7, 9]. It is not proposed to repeat here the details of planting and cultural operations but rather to describe some of the points noticed by the writer on his visit, particularly those where there were differences in practice on the various estates.

In the first place it should be made clear that the general way in which the crop is cultivated in Mississippi and Louisiana differs from that in Florida. Most of the Florida groves are smaller than those in the West, more money is spent on clearing the ground and later cultivation and fertilisers, and relatively large yields are required if they are to be run at a profit. Many of these groves are not the sole source of income of the owners and it does not seem to be essential in every case that they pay their way.

By contrast the groves in the West, which generally cover enormous areas, are established at low clearing and cultivation costs with the idea that the modest yields obtained from trees receiving little attention will more than balance the low running expenses. It is in this fundamental difference of outlook that the reasons lie for many of the differences in procedure.

Clearing the land.—In Florida it is customary to clear the land completely before planting. Contour ploughing and terracing were not employed on the older plantations, but are to be seen in the new 3,000 acre plantation of Messrs. Larsh at Lamont. In Florida the land is often so flat as not to require any special treatment and the growers tend to be prejudiced against terracing because of the inconvenience when cultivating.

It has been the practice in Louisiana and Mississippi only to remove a proportion of the stumps when clearing new land. The site is surveyed and rows, generally 30 ft. apart, are laid out following the natural contours, terraces being made where necessary, but the stumps lying between the rows are left in place. Such a procedure allows of tremendous reduction in the cost of clearing the land but taken all round is an economy of doubtful value.

On Mr. Lamont Rowlands' plantation at Picayune, Mississippi, it was originally intended to reproduce as far as possible the conditions under which tung grows wild in China—the stumps between the rows were left in to rot and the trees were to have practically no attention at all. It was found, however, that after 3 or 4 years moderately good growth the soil appeared exhausted and cover-cropping and cultivation were necessary if the trees were to make further progress. Furthermore, the stumps of longleaf pine are

very slow to rot on account of their high rosin content, so that before cultivation it was still necessary to remove those left between the rows.

A modification of this procedure is to clear only the rows at the time of planting, and to remove the remaining stumps left between them at leisure during the first 2 or 3 years' growth of the trees. This has as its advantages : a reduction in cost of first clearing the land ; easier removal of stumps that have had a little time to rot off ; and, that the land should be entirely cleared for cultivation by the time the trees are 4 or 5 years old, when cover-cropping becomes necessary. There is also a saving in time in only partially clearing the land before planting, and as the remaining stumps can be pulled at leisure only a small labour force is needed for the later operations. As against this there is the difficulty of removing the stumps in the restricted space between the rows without damaging the young trees, and the set-back in growth that results from the absence of cultivation and cover-crops between the rows from an early stage. Large areas of tung land have been cleared in this way, but it is significant that more than one of the growers with whom I spoke, having tried the method, considered that on the whole it is better to remove all the stumps and to prepare the ground completely before commencing planting operations.

The technique used for removing stumps on one of the plantations visited is described below. It is understood that, with minor variations, this method of clearing is generally used on the Mississippi and Louisiana groves. Basically it is that an extremely stout, heavy, hook-like instrument, rather resembling a hard-pan breaker, is drawn against the stumps by means of a 60 h.p. tractor. The " hook " is normally supported by a small simple crane mounted at the rear of the tractor. It is held by a rope wound two or three times round a slowly-revolving winch, and can thus be let down in position by simply taking off one of the turns on the rope. The tractor then draws it into the stump which either splits in two or lifts out of the ground. As the latter is rather heavy work for a 60 h.p. tractor it is considered desirable first to split the stumps by means of the hook and then to lift the two halves separately. Another type of hook has a broad end flattened in the horizontal plane. This brings the stumps out whole, rather than splitting them.

It is, of course, far easier to draw the stumps if they are no longer green and have been allowed to rot for some little time. A very large proportion of the stumps on most of the land cleared for tung growing are of the turpentine or longleaf pine (*Pinus palustris*) and are of considerable value for the distillation of pine oil. When the land to be cleared is situated near a still it has sometimes been arranged that the distiller removes the stumps free of charge, retaining them as raw material for his plant. In other cases the grower clears the land and sells the stumps, but as they are bulky

transport is expensive and it does not pay to do this unless the still is near at hand.

Planting.—It should be stated at the outset that, up to the present, tung is practically always grown from seed. Budding and grafting have not yet progressed beyond the experimental stage (see p. 26).

As in the case of land-preparation, we have here again in the planting practice two different systems in use and it is of interest to discuss their relative merits. They are (i) planting the seed directly in the field and (ii) rearing in the nursery and planting out after one year's growth.

Early experiments made in Florida with planting directly in the field were not particularly successful, but large-scale plantings in Mississippi and Louisiana have shown that with proper care very satisfactory results may be obtained. In the 3,000 acre grove of Messrs. Larsh at Lamont in Florida direct planting has been followed, and the growth made in the first season is very striking (Plate I, figs. 1, 2).

The seed is planted in April in holes about 6 in. deep (two or usually three seeds to each hole), together with a little compost or organic fertiliser such as Peruvian guano. During the first two years constant cultivation is necessary in order to keep the weeds from choking the young trees. Agricultural paper was tried for this purpose in Florida, in the same way as it is used in the Hawaiian pineapple industry, but the expense proved too great. During the first season it is necessary also to remove extra seedlings where more than one have grown from the same hole.

In the case of seedlings grown in the nursery similar cultivation is required to keep down weed growth, but the area concerned is relatively small. No very special preparation is required for nursery land. The best soil is a silty loam—this is thoroughly worked and a little fertiliser added, usually along the rows where the seed is planted. An average of between 200 and 300 lb. per acre of general fertiliser mixture applied in this way is regarded as generous. It is not considered wise to apply fertiliser too liberally in the nursery, as the seedlings are then liable to serious setback when planted out in the field where heavy fertilising is impracticable. The seeds are planted in early spring at a depth of 3 to 4 in. and spaced about 1 ft. to 18 in. apart in the row. The transplanting technique varies slightly in detail with different growers and accounts are to be found in the literature. The main outline is the same in most cases. At the bottom of the holes, which may either be dug by hand or by a mechanical digger, compost or other fertiliser is mixed with the soil: the seedlings are then set, earthed up and usually watered. Before transplanting, the stem is cut to within about 6 to 8 in. of ground level, the longer roots are trimmed, and the remaining root system is often dipped into a pail of water. All this takes place during the dormant period, usually very early

PLATE I.

TUNG OIL INDUSTRY OF THE UNITED STATES.

FIG. 1.—SEEDLING OF "LOW-HEADED" TYPE.

FIG. 2.—SEEDLING OF "HIGH-HEADED" TYPE.

facing page 14.

PLATE II.

TUNG OIL INDUSTRY OF THE UNITED STATES.

FIG. 1—FRUIT OF "CLUSTER" TYPE.

FIG. 2 FRUIT OF "SINGLE" TYPE

facing page 15].

in the spring. When growth restarts a certain amount of disbudding may be necessary to prevent the tree developing into the multi-trunk type.

This cutting back at the time of transplanting is avoided in the case of plants grown directly from seed and no disbudding is needed to control the branching. It is claimed that on this account the trees get a better start than nursery stock. On the other hand most growers agree that the expense of intense cultivation of the entire grove during the early period, when direct planting in the field is used, more than offsets these advantages. The factor of watering the young seedlings is one that must be borne in mind—this could always be done in the nursery if necessary, but watering a 3,000 acre grove is another matter. In addition it is pointed out that a very much better selection of stock may be made in the nursery.

Another matter of great importance that arises in connection with planting is that of spacing. The ideal spacing will, of course, be governed by a number of factors, the chief being the soil conditions and the amount of fertiliser employed. Growers generally tend to plant closely, thinking that even if the trees are not so well developed, the larger number retained will still give a greater total yield. That this outlook can be fallacious has been shown in the case of some crops (pecans provide a very good example), but so far there appears to be no reliable numerical data available for yields at different spacings with tung.

Many of the Florida groves are planted on the square with a spacing of 22 to 29 ft. In Mr. Bennett's groves the spacing is $26\frac{1}{2} \times 26\frac{1}{2}$ ft. (Plate IV, fig. 1) and he cultivates along and across the rows in successive years. At their present size (9 years old) the trees appear to have sufficient room, but if they grow much larger that will interfere with one another. In the Alachua Tung Oil Company's groves the trees are spaced 29×29 ft. in some parts and, where conditions are favourable, fine trees have developed. Unfortunately, it is not possible to compare the yields with those of Mr. Bennett's grove, because, on account of its unfortunate site with regard to altitude and air drainage, the crop on the Alachua plantation suffers from frost damage almost every year. A system commonly adopted in Louisiana and Mississippi is to leave 30 ft. space between the rows, but to plant at 15 ft. in the rows, with the intention of removing alternate trees about the fifth year. This has been adopted also on the Chase and Company's plantation at Lamont in Western Florida. The idea is that the alternate trees which are removed will give two or three crops before they are dug up—the temptation for the grower is always to " leave them for another year, as there might be a particularly good crop next season." In practice it seems to be the rule that the growers fall to this temptation, and finally the trees become so large that it is impracticable to remove them. Mr. Rolf K.

Buckley, of the Alachua Tung Oil Company's plantation at Gainesville, is the only grower that I met who had had experience of removing grown trees. In a part of this plantation the trees are spaced at 15 ft. in rows 29 ft. apart, and on one section of this he had taken out alternate trees when 4 or 5 years old. He assured me that it is an extremely difficult operation, involving high labour costs. In digging out the stumps damage to the roots of the neighbouring trees was unavoidable and the disposal of the trees taken out proved difficult. They could not be burnt *in situ* without damage to the grove, and on account of their shape they did not bunch readily and were accordingly exceedingly bulky to transport away. In Mr. Buckley's opinion the labour involved in taking these trees out was out of all proportion to the small gain of two or at the most three years' crop from them.

On the Chase and Company's grove at Lamont the trees (5 to 9 years old) are particularly well grown and the removal of alternate numbers in the row would obviously be a matter of great difficulty. The branches of neighbouring trees are well interlaced, and even between the rows (30 ft.) in some cases the branches nearly meet.

To what extent this interference affects the yield is not definitely known, but it clearly aggravates the damage done by a fungus rot that is attacking the trees in some parts of Florida. This pest, *Clitocybe tabescens*, is soil-borne, and spreads along the rows from the roots of one tree to another.

The general opinion among members of the United States Department of Agriculture staff engaged on tung work was that a wider spacing, say 25 ft. in the row with rows 30 ft. apart, would probably give larger yields over a long period, and would certainly develop healthier trees. Some growers have the idea of growing pasture in their tung orchards when the trees become thoroughly mature, and so raising stock in conjunction with the tung. It must be pointed out, however, that in order to do this, a wide spacing of the trees would be essential, at least 30 × 30 ft. or the shading would be too great.

Crop Management.—Particulars of cultivation and fertilisers used are given in some of the publications on the crop [1, 3, 5, 6, 7, 9] so that little need be said here on these aspects of the subject. Cultivation is necessary, especially during the earlier years, in order to keep the weeds down, and is carried out as a rule by discing along the strips next to the trees. This takes place twice a year in the large plantations in Mississippi and Louisiana, but in Florida the operation is usually carried out more frequently. Care must be taken not to cultivate too deeply near the trees as the roots do not lie far below the surface of the soil. (It is said that the tung tree has a tap root ; this is the case initially, but the condition does not remain for long as development of the main root does not keep pace with that of the branch roots which soon outgrow it.)

The quality and type of fertiliser used will depend on the soil

and the manner in which any grove is being run. Basic slag is in fairly common use as a general fertiliser. The hulls and cake from the tung mills are usually returned to the ground; their nutritive value is not large but they improve the physical state of the soil by providing additional colloidal matter. Cases have been observed when application of the ground hulls appeared to cure bronzing (due to zinc deficiency in the soil) but the only explanation for this seems to be that the material passed through lengths of zinc-lined piping in the mill. Among other materials used are organics such as guano and artificials supplying nitrogen, phosphates and potash: the latter may sometimes be composted with leaves. Green manure is supplied by cover-crops that are ploughed in.

Fertiliser is applied annually on the higher-yielding groves, and most other groves make applications from time to time. On Mr. Rowlands' plantation at Picayune it was originally intended to do without fertilisers entirely. The remarkable response that has been obtained from a few small experimental applications on this land now convinces the owner that the practice may be worth while. Similar striking recoveries are to be observed where cover-cropping has been introduced on plantations that have hitherto received little attention.

Crotalaria spectabilis is most commonly grown as a summer cover-crop. It makes good growth and reseeds without attention, but has the disadvantage that it is poisonous to stock. Other species, not having this drawback, particularly *C. intermedia* and *C. striata* are being tried out. I saw an extremely good growth of the former on the United States Department of Agriculture Experimental Farm near Bogalusa, but some growers claim that it is difficult to establish in competition with weeds and does not reseed very easily. Soya beans have been used, the seed may be harvested and sold, and cowpeas have also been suggested.

The value of winter cover-crops is being tested at the University of Florida Agricultural Experiment Station and by the United States Department of Agriculture Tung Oil Investigation Staff, and it seems likely that they will prove more satisfactory than summer crops, as they do not enter into competition with the tung trees for water, etc. Types of local vetch are grown for this purpose. It should be possible to grow both a winter and a summer cover-crop.

At the moment only a summer cover-crop of *C. spectabilis* is grown on most of the plantations. There is some difference of opinion as to the best time to plough the crop under. On Mr. Bennett's groves this is done in September so that the ground is clear for gathering the fruits when they fall in October. September however, can be one of the hottest months of the year and soil temperatures up to 135° F. may be experienced 6 in. below the surface where there is no covering layer, so that this early ploughing under may easily be injurious to the bacterial flora of the soil. It

may also be objected that most of the nitrogenous matter supplied by the cover-crop may be leached out of the soil while the roots are still dormant, leaving little for the time when they become active again in the following spring. In order to overcome these difficulties, Mr Buckley (Alachua Plantation) has the cover-crop beaten down just before the fruits fall, so that they can be gathered easily, then allows the material to rot until late winter or early spring, when he ploughs it under so as to be available for the roots at the beginning of the growing season.

No regular pruning is required, but attention is necessary at certain stages in the shaping of the trees. As some of the aspects of branching must be dealt with under Section (*h*) it seems advisable to leave the consideration of the whole problem until then.

(*f*) *Yield*

The variation in yield per acre among different tung orchards, and in the same orchard in consecutive years is so great that any figures are practically valueless for purposes of generalisation. This is in part due to the extreme variation of the trees and hence of the composition of different orchards, but chiefly to the frequent frost injury which may involve a loss of anything up to 90 per cent. of the year's crop.

Yields of individual trees are totally misleading on account of this variation. Records of mature trees in the Horticultural Test Grounds at Gainesville University [5] show the average yield of nuts (seeds) from ten trees over a 13-year period (from their ninth to twenty-first year) to be 22·7 lb. The individual trees, which are all well grown and in healthy condition, have 13-year averages ranging from 4·7 lb. to 67·3 lb., there being four occasions on which the heaviest cropper bore 90 lb. of nuts or over, while the record yield was 164·8 lb. In the field, average yields of about 10 lb. per tree are more general, working out at some 500 to 600 lb. per acre under the spacings most commonly adopted. 500 lb. of nuts per acre is regarded as a good yield in large areas, even when frost damage is very slight, and under present conditions growers can hardly expect to maintain this figure.

As might be expected the composition of the fruit is also liable to some variation. The following figures give a general picture. In the average air-dry fruit the outer husk (hull) accounts for about 40 to 50 per cent. of the weight. Of the 50 to 60 per cent. which constitutes the nuts, rather less than 40 per cent. is shell and the remainder kernel. The oil content may be expressed as nearly 20 per cent. of the whole fruit (air-dry) or around 38 per cent. of the unshelled nut and 60 per cent. of the kernel. In practice not all this oil can be expressed, and if 17 per cent. by weight of the air-dry fruit is obtained (i.e. about 50 per cent. on the air-dry kernel) the operation is regarded as very efficient.

Mr. B. F. Williamson of the General Tung Oil Corporation in

Gainesville claims that oil content of the nuts can be increased by the use of fertilisers. He informed me that in some experiments that he had carried out yields of up to 19 per cent. (by weight, air-dry fruit) had been obtained from well fertilised trees, as compared with 15 per cent. from the controls and only 13 per cent. from trees which had been starved. Other experiments, however, undertaken at the University Agricultural Experiment Station [5] do not show any definite correlation between fertiliser treatment and the percentage oil content in the nut beyond that badly starved trees often produce nuts which are poor in oil chiefly as a result of incomplete filling of the kernels.

To sum up—taking a good yield of nuts from mature trees to be 500 lb. per acre, as mentioned above, we can assume that 38 per cent. of oil would be recoverable from this crop, giving a figure of about 190 lb. per acre for the yield of oil. With the present heterogeneous stock and the prevalence of frost injury this seems the highest that can be generally expected until improved strains are developed.

(g) *Diseases, Pests and Physiological Troubles*

Mention has already been made of the fungal rot caused by *Clitocybe tabescens* (an Agaric somewhat resembling *Armillaria mellea*). This first attacks the roots and quickly spreads upwards through the cambial region to the branches, finally ringing them and killing the tree entirely. In the cases that I saw the infection had reached about 3 or 4 ft. above the ground-level and copious gumming of the bark was noticeable in the affected areas. No fructifications were seen. Where outbreaks occurred the disease had spread to neighbouring trees in the row when the infected tree had not been removed at an early stage. No special control measures have so far been taken.

Up to the present the damage from this fungus is very small (I noticed it only at Lamont in Florida) but by spreading in closely planted orchards it might quickly become a menace and it seems important that the problem of its control should be tackled without delay. It is known that the fungus is widely distributed and occurs commonly on a number of trees native in the district. No other fungal diseases of the tree are known in the United States.

A certain amount of damage is caused by leaf-scale, but it is not sufficient to warrant any special control measures being taken.

Eel-worms (*Heterodera marioni*) causing root-knot have in some cases proved injurious to tung seedlings, but it has been shown by Dickey and Mowry [8] that the plants outgrow the injury and that older trees are not susceptible.

A physiological trouble known as " bronzing " has been common in many of the groves, and caused considerable damage until remedial measures were discovered. The earliest symptoms of the

trouble are seen in a deformation and very slightly bronzed appearance of the young terminal leaves, often showing first in the spring. A little later in the season the foliage takes on a bright yellowish bronze colour and a decidedly sickly appearance in severe cases; extensive die-back of the twigs and branches may occur during the following winter. The trouble was prevalent on a number of different soil-types, but seemed particularly common in groves planted on worked-out land.

It has been found that treatment with zinc, either by spraying on the leaves or by application through the soil, acts as a corrective to bronzing. The application can be made in a number of different forms with equally satisfactory results, but zinc sulphate is generally employed as being the cheapest. Applications of ¼ to ½ lb. per tree of the salt containing one molecule of water of crystallisation ($ZnSO_4.H_2O$) are made, according to the age of the tree and the severity of the damage. Rapid recovery is usual. The exact mechanism of this effect has not yet been thoroughly investigated—whether it is a case of simply replacing zinc deficiency in the soil, or if the zinc salt applied has some indirect physiological action. It is interesting to note that the "rosette disease" of pecans and chlorosis of satsuma oranges frequently occur on plots adjoining tung plantings where bronzing is prevalent and that these troubles have been shown to respond to zinc treatment. This problem is discussed in some detail by H. Mowry and A. F. Camp [6].

Slight trouble has been experienced on some plantings from partial chlorosis known as "frenching," but it has rarely been of any great importance. Work at the University of Florida Agricultural Experiment Station indicates that application of manganese sulphate to the soil gives effective control [7]. Symptoms of partial chlorosis have also been attributed at times to excess of lime in the soil.

Cases of what is known as "overstrain die-back" occur occasionally in trees following a year of particularly heavy cropping. There is die-back of terminal twigs and young branches, but the trouble appears to be only of a temporary nature as the trees quickly pick up again.

(*h*) *Investigation Work*

While due importance must be attached to the experimental work that is being carried out on problems of fertilisers and cover-crops for tung plantations, it is in the field of selection and breeding to improve the stock that the greatest advances seem possible. The tung tree is extremely variable; indeed the variation appears so general that one is forced to look upon the trees more as individuals than as examples of a number of different varieties. From this heterogeneous stock, then, it should be possible to select and improve the general standard of the plants grown.

A few more or less characteristic forms have been noted:

"cluster-bearing" (Plate II, fig. 1) and "single" (Plate II, fig. 2) type of fruiting, the Craig Kidney variety having giant fruits containing up to 20 or 30 nuts and "Moorei" (Plate III, fig. 1) which has a whippy habit and bears numerous dwarf fruits. The last two can be regarded as abnormalities, and it seems a little doubtful if any of these types could be ascribed varietal status from a strictly botanical point of view. The immediate problem, however, is not so much one of taxonomy, but rather a matter of seeking to correlate factors connected with or influencing yield. It might be split up into a number of individual problems thus:

(1) Selection of trees with the greatest inherent yielding capacity. Subsidiary to this would be the question of seeking correlation between yield and visible factors, by which high-yielding trees might be recognised at once.

(2) Selection for factors that will favour yield. In the United States the problem of developing frost-resistant stock is of more immediate importance than that of the yield itself. Questions of branching phenomena, etc., would come under this section, and also an investigation of the possibilities of inducing such characters as frost-resistance or late flowering by artificial means.

(3) Breeding work, which can be carried out both independently and also with the aim of combining factors selected under (1) and (2).

(4) Methods of vegetative propagation to ensure that the characters of desirable strains can be maintained.

Research work on problems arising in connection with tung growing has been carried out for a number of years at the University of Florida Agricultural Experiment Station at Gainesville. Here, in spite of limitations of staff and time, important ground has been broken, mostly in the field of fertiliser and soil problems (the case of the work on the treatment of bronzing being an outstanding result). Propagation and breeding experiments have been undertaken on a small scale, but it has not been possible to carry this work very far. Research work in some directions has also been undertaken at the University of Georgia Experiment Station [9, 10], but I was not able to visit this centre.

The United States Department of Agriculture has recently undertaken a long-term research into tung problems and a number of workers are now stationed at different parts of the tung belt. A botanist and a biochemist are attached to the University of Florida at Gainesville, but most of the staff are at Bogalusa, Louisiana, where the work is centred. Here there is excellent laboratory accommodation practically completed, a large experimental farm, and in a number of neighbouring plantations, plots are set aside where the staff carry out trials of different types. The research programme includes selection, breeding and propagation work, fertiliser trials, anatomical and cytological studies of the trees to elucidate flowering and fruit development, and a comprehensive examination of the oils, methods of extraction and possible new

applications. A refrigerator chamber is being installed for work on frost-resistance. As already mentioned this undertaking is a very recent development and no immediate results can be expected.

Some account may now be given of the problems outlined above and of any advances that have been made towards their solution.

(1) In the United States any work on the selection of high-yielding trees has been hampered from the start by the fact that in recent times a large part of the crop has been destroyed every other year by frost damage. It must be borne in mind then that trees that are potentially good bearers may escape notice if they happen to grow in some site where frost damage is severe. In spite of these obstacles, however, it is known that the capacity for bearing varies very greatly in different trees, and that many individuals are consistently heavy bearers. Up to the present, heavy bearing seems about the only safe criterion for the quality of a tree. Size, shape and habit of growth appear to mean very little, as no particular type can be correlated with yield and prolific flowering does not necessarily indicate heavy fruiting. Only in the difference of "single" and "cluster" types (Plate II, figs. 1, 2) is there any indication of a higher-yielding strain. Cluster-type trees generally outyield singles, but even this cannot be stated categorically, for in older trees the singles tend to catch up and the heaviest crops recorded are from a single type tree [5]. (This tree which is growing in the Horticultural Test Grounds at Gainesville is now 26 years old. It gave an average yield of nearly 70 lb. of nuts (not fruit) over the 13 years from 1922-1934, with a record of 164·8 lb. in 1931.)

The essential difference between these two types lies in the arrangement of the inflorescence. The flowers of the tung tree are unisexual, staminate and pistillate flowers being separate. They are borne in loose cymes, which in the case of the single type consist of one pistillate flower surrounded by a number of staminate flowers, so that only one fruit can develop. In the cluster type, five or six pistillate flowers occur in the cyme and a cluster of five or six fruits may result in favourable circumstances. As a rule individual trees remain true to type, bearing their fruits either singly or in clusters, but exceptions do occur when a single type tree may bear some of its fruit in clusters or *vice versa*. An intermediate state occurs commonly which has been given the name of a "pseudo-cluster." Here a number of single type inflorescences are borne close together at the end of the branch. At the fruiting stage this has the appearance of a normal cluster. Every gradation between this and the true cluster seems to occur usually on trees that would be designated as cluster type.

At one time singles were considered superior to cluster type, but opinion has changed, and on most of the plantings since 1930 where selected seed has been used, the cluster-bearing habit was the

criterion of selection. Where possible the seed was taken from high-yielding trees. Nevertheless, with such heterozygous stock it was inevitable that many poor quality trees would result even from the most carefully selected seed.

Little need be said of the Craig Kidney and Moorei varieties as both are inferior yielders. The giant fruits of the Craig Kidney give trouble in the decorticating machines. The Moorei variety has all the appearance of virus infection (Plate III, fig. 1), but is considered to be an inherited deformity. It appears in the ratio of one in eight among the progeny of a few normal-looking trees on the groves of the Alachua Tung Oil Company at Gainesville. The plants make rather whippy growth and never attain any size, but according to Mr. Buckley they are prolific bearers of very small fruit. It seems extremely unlikely that the variety would prove of any value commercially.

By way of collecting data for correlation and genetical studies the United States Department of Agriculture staff are working on two experimental nurseries of over 40,000 plants each. The progeny of parent trees is kept separate and periodic measurements are made of growth, etc., for record purposes.

(2) Of the factors that might influence yield, that of frost-resistance is the most important. As already mentioned, the main frost damage takes the form of injury to the blossom, as in the case of the apple crop in this country. It seems that this problem might be overcome in two ways—by selecting or developing either (*a*) frost-resistant strains or (*b*) strains in which flowering is delayed until after the period of danger from freezing.

It is established that certain trees regularly escape frost damage when those immediately around may frequently be affected. This is a clear case of either frost resistance or late flowering, but it has not yet been established definitely to which cause the immunity of these trees is due. From general observation, Dr. Potter seemed to think that it was a matter of actual resistance to freezing rather than time of flowering. The latter possibility cannot be ruled out, however, as there is considerable variation in the time of flowering of individual trees, the extent depending largely on the season. There is commonly a period of from 1½ to 2 weeks between the time of maturity of the first and last flowers on a single tree.

Seed from a number of " frost resistant " trees has been collected and is being grown for investigational work at Bogalusa, where experimental studies of frost damage will be made with the help of the refrigeration chamber next flowering season.

The possibilities of inducing frost resistance or delayed flowering by artificial means have not been overlooked, and experiments to find the effect of cold treatments on the seed may be undertaken. It is well known that a polyploid condition may be brought about in many plants by treatment with colchicine often involving only a simple technique : furthermore there are cases recorded where

polypoid forms have shown marked frost-resistance. This then is another aspect of the problem which might be examined.

As a cultural measure to overcome frost damage it should be noted that Alburtus Miller, who is manager of Mr. Bennett's plantation, claims that heavy applications of fertiliser in the autumn have a delaying effect on flowering in the following season. This might be considered in connection with the time of ploughing in cover-crops.

The following account of branching phenomena of the tung trees is included in this section owing to the bearing that it may have on selection work, as the different types of branching appear to be inherited characters.

At the seedling stage two fairly well-defined types exist. The one (Plate I, fig. 1) will begin to throw out branches when between 3 and 4 ft. high or even lower, while the other type (Plate I, fig. 2) does not branch until later when it may be nearly 5 ft. high. There is a further difference in the spacing of the branches; those of the low-branching or "low-headed" type are well spaced, while in the "high-headed" type the branch-nodes are close together, all the branches in the first season's growth arising over a length of less than 7 or 8 in., and in addition the angle of branching is often wide so that weak crotches result. These characters are constant in the plants, for if cut back to within 6 or 8 in. of the ground the bud which takes on the growth repeats the behaviour of the main shoot. Mr. Buckley at Gainesville is particularly interested in this question of branching types, and has carried out some experimental work at the Alachua plantation. I understood that the results of his work, which deals with the inheritance of different branching habits and their possible correlation with bearing, are to be published shortly.

Apart from the implications that these branching types may have in selection work it is of interest to know something of their behaviour from the point of view of shaping the trees. Naturally the trees growing from these two types of seedling show considerable differences in form.

It may sometimes be useful to determine the types in the nursery as early as possible, and in that connection the following note on leaf-form is of interest. The youth-form of the seedling leaves is lobed—usually three-lobed but occasionally five—it was noticed that the first branch is indicated by a change to the mature form, i.e. it occurs in the axil of a cordate leaf. Accordingly it may be taken that, with rare exceptions, the appearance of the first cordate leaf indicates that a branch will be developed.

One of the troubles experienced in tung cultivation arises from the occurrence of weak crotches in the trees. These are liable to break if there is a heavy crop and considerable damage may result. The branches of the high-headed type are often so closely spaced that as the trees grow larger they develop in effect into a whorl. This is reasonably strong provided the terminal bud continues

PLATE III.

TUNG OIL INDUSTRY OF THE UNITED STATES.

FIG. 1. "MOOREI" VARIETY OF *A. FORDII*

FIG. 2. "CARRIAGE-WHEEL" BRANCHING.

facing page 24.

PLATE IV.

TUNG OIL INDUSTRY OF THE UNITED STATES.

FIG. 1—PLANTATION OF SINGLE-TRUNK TREES.

FIG. 2—BOLE OF MULTIPLE-TRUNK TREE.

facing page 25.

growth, but if for any reason it does not a "carriage-wheel" joint (Plate III, fig. 2) is formed which is very liable to split down the trunk. This is likely to occur in two ways: If a high-headed seedling is late in developing or makes weak growth it may not have branched before winter sets in. In such cases branching takes place at the beginning of the next season, but the plant is often too weak for the terminal bud to continue growth. This trouble can be avoided by cutting back to within 6 or 8 in. of the ground any seedlings that have not begun to branch during the first season. In other cases dying of the terminal bud often occurs after flowering when the bud which should take on the terminal growth fails to develop.

Another problem on which there is difference of opinion among growers is that of the relative value of single-trunk (Plate IV, fig. 1) and multiple-trunk (Plate IV, fig. 2) trees. The latter type arises when at the time of transplanting the seedling is cut back and a number of buds are allowed to develop. This normally takes place, and if single-trunks are required disbudding is necessary. Most growers claim that multiple-trunk trees are not mechanically strong and are therefore liable to damage by wind, particularly when bearing heavy crops. The Chase and Company's plantation at Lamont has not so far borne this out: the trees there are all multiple-trunk type, and the oldest were planted out in 1932, but I saw no evidence of breakage. It is argued that considerable trouble is necessary in disbudding seedlings in order that they should develop into single-trunk trees: if instead the trees were allowed to grow multiple-trunks and the attention were given to disbudding in order to space the branches properly then there should be no trouble from weak crotches.

Attention is also necessary to prevent the development of adventitious buds on the trunks of the trees. These grow into branches (Plate III, fig. 2) having very poor connection with the main mechanical system of the tree and are therefore extremely weak at the crotch.

An interesting example of the extraordinary regenerative power of tung trees is given in the severe "pruning" measures taken on one of the Louisiana plantings (Mr. Riemers' at Pine Grove) where the trees had received little attention before. On one section of the grove it was decided to trim the 5-year-old multiple-trunk trees, leaving only a single trunk. This had been done only last winter and when I saw them in the following October the scars were almost completely overgrown with callus formation and scarcely visible.

(3) There has so far been scarcely any breeding work undertaken with tung trees. Hybridisation experiments have been attempted at the University of Florida Agricultural Experiment Station, but the trees on which crosses were made are growing in an unfavourable situation, and the entire crop has been destroyed each year by frost. Breeding work is planned by the Department of Agriculture staff

at Bogalusa, and the possibility of making interspecific crosses is not excluded, bearing in mind that *Aleurites montana* flowers later than *A. fordii*. A difficulty that has to be faced in breeding work, and indeed in selection work also, is that germination of the seed is sometimes very poor. This appears to be an inherited character and is very noticeable when going through experimental nurseries where seeds from the same parent trees have been grouped. Some lots have very low percentage germination indeed.

At the present state of our knowledge of the tung tree, breeding work must of necessity be carried on empirically, but as selection work progresses it should be of greater service in combining such characters as high-yielding capacity and frost resistance in the same plant.

(4) As desirable types of tung tree are developed by selection and breeding work the problem of retaining their characteristics by vegetative propagation becomes increasingly important. Grafting experiments have been undertaken at Gainesville but generally ended in failure. With the use of a plant hormone (indoleacetic acid) a number of root-cuttings had been induced to "take," and when I saw them they showed a tolerably good season's growth. I understood, however, that only about 20 per cent. of the total had been successful.

Budding appears more promising, but in Florida it is claimed that after the first year or two the budded trees become less vigorous than those grown from seed. On the University Experimental Farm at Gainesville there are a number of rows of budded trees growing side by side with seed-grown specimens planted at the same time, and the latter are certainly larger in size. There was formerly an area of budded trees on Mr. Bennett's grove, but they have now been dug out owing to their poor development. It must be mentioned, however, that the budding material used in Florida appears to have originated from few trees and that no very extensive trials with a wide selection of material have been carried out. Furthermore, I saw a small area of budded trees in Mississippi, reputed to be the oldest in the country (7 to 8 years), and these showed no difference in size or vigour from the neighbouring seed-grown trees of the same age.

In the Department of Agriculture research programme further extensive work is being done on budding before abandoning the use of the method. Some three hundred trees have been selected as parent stock and numerous budding trials are being carried out on seedlings grown from them. The work has already shown that there is great variation in the facility with which different trees respond to budding treatment. Buds taken from the progeny of certain trees took successfully in 95 per cent. of the trials, while with other material there was a very high proportion of failures.

In general, however, it may be said that tung trees may be budded easily, and no great care is needed in carrying out the

PLATE V.

TUNG OIL INDUSTRY OF THE UNITED STATES.

FIG. 1.—PATCH-BUD.

FIG. 2—SPRING-BUDDED TREES.

facing page 27].

operation. The technique applied is that of patch-budding (Plate V, fig. 1), and even in cases where the patches have been secured only by elastic bands and not bound with grafting tape, perfectly successful results were obtained. The bands should be removed after two or three weeks or they become incorporated in the callus formation. When the bud is to be forced the stem is cut a few inches above the patch. Frequent attention is needed for several weeks in order to remove the numerous adventitious buds that arise round the margins of the patch, for if left for a couple of weeks it is often impossible to distinguish between these and the inserted bud. The experiments at Bogalusa have certainly given vigorous plants in the early stages, but it is understood that this was also the experience in Florida. Fertilised with 200 to 300 lb. per acre of complete fertiliser mixture (N.K.P. in ratio of 4 : 8 : 4) applied along the rows buddings made in the spring had reached up to 12 ft. in height during the one season's growth (Plate V, fig. 2). This is, of course, much too large for convenience in transplanting but does at least indicate that the buddings had started vigorously. The ideal system from the point of view of convenience would be to bud in the autumn and force the buds the following spring after transplanting. Trials are now being conducted at Bogalusa to find whether this autumn-budding will give successful results, and it is understood that one grower is taking the risk and planting out a very large area of land with autumn-budded stock in the coming season.

The even growth of the budded seedlings and the uniformity of branching in each lot is a striking testimony to the value of budding for maintaining the characters of desirable stock in propagation, provided that the later loss of vigour reported in Florida does not prove an insuperable obstacle. Once perfected, multiplication by this method can be quite rapid, for a well-grown seedling of the low-branching type may easily provide 25 buds at the end of the first season. Even assuming that 50 per cent. of these were blind and therefore useless for propagation, and allowing for a certain number of failures, theoretically over 1,500 plants could be derived from a single specimen after three season's work.

(*i*) *Treatment of Fruit*

The fruit falls from the trees during the latter part of October and early November and can be gathered at leisure. The gathering must be taken into consideration in cultivation and cover-crop practice; for example, if a winter cover-crop is to be grown the land should be disced and the seed sown before the fruit begins to fall.

Generally the fruits are collected together in heaps or put into sacks at the base of the tree, and allowed to dry. Mr. Bennett has on his plantation a number of storage sheds, simply constructed from local timber, but this is not the usual practice. The fruits

may be taken into storage at the mill but expression of the oil does not commence before January.

A number of mills were visited, but apart from minor details they were all very similar, employing the same type of machinery made by the same makers, and in most cases the same size. The recently-built "model" mill at Brooker, near Gainesville, may best be described.

Lorries bringing in the fruit first pass over a weigh-bridge, and then discharge their load at one end of the building. The fruit is next conveyed by means of a moveable elevator into storage cages built of a wooden framework with stout wire netting that permits of good aeration for drying. In this way the fruit supplied by different growers can easily be kept separate. The different cages have doors opening on to a narrow central passage where a conveyor at ground level carries the material to the hulling machinery. After weighing and sieving to remove dirt the charge is hoisted by means of an elevator and passed under an electro-magnet before entering the hulling machine. The purpose of this is to remove any particles of iron or steel likely to damage the machinery, as such foreign material is sometimes added deliberately by the gatherers to increase the weight that they bring in.

The Bauer huller and separator (made by Messrs. Bauer Bros., of Springfield, Ohio), which is used in all the mills, appears practically identical with the plant supplied for this purpose by Messrs. Richmond and Chandler in this country. In the hulling operation it is considered desirable to leave about 50 per cent. of the inner shell attached to the nuts as this improves the consistency of the resulting meal for pressing purposes. The fragments of shell and outer husks recovered from the process are ground and used for fertiliser. At the Brooker mill it was the practice to reduce them to a fine flour by means of a high-speed rotary grinder, and the resulting dust that escaped was unpleasant in its effect on the workmen. Other mills visited reduced the hulls only to a coarse granular mass using slow grinding mechanism. As already mentioned the material is useful for fertiliser mainly because of the beneficial effect that it has on the physical consistency of the soil, though, if applied too thickly it is apt to become waterlogged in wet weather.

After the husks have been removed the kernels are ground and passed on a continuous band feed to the expeller. This machine is the limiting factor in the speed of operation of the plant, and any excess of meats when the expeller is working to capacity continues on the band feed and is brought round a second time. Cake from which the oil is not completely expelled may also be put through the machine a second time, mixed with fresh meats.

The expellers employed in all the mills I visited were manufactured by the V. D. Anderson Company, of Cleveland, Ohio, and were of the normal type used for handling oilseeds. I understood

that the French Company of Piqua, Ohio, are also manufacturers of expellers suitable for this work, but I did not see any of these machines.

The oil removed in the expeller is pumped into a temporary storage tank where the foots are allowed to settle, and is later reheated and put through a filter-press of the type with side feed. The cake is useless as a stock feed, being injurious, but has value as a fertiliser.

I was informed that the most satisfactory type of pump to use in handling the oil at the mill seems to be that working on the slow piston principle. High speed rotary pumps have proved unsatisfactory owing to damage and rapid wear caused by particles of grit present in the oil. A certain amount of diatomaceous earth is also present after the filter-press treatment, as this is used as a filter-aid. Pumping with compressed air was found totally ineffective according to Mr. Buckley.

Figures given verbally relating to rate of operation, yield of oil, etc., appear to vary somewhat. In considering these, the rate of passage through the expeller and the efficiency of extraction must be taken together, for this rate can be considerably increased at will, but of course with a loss of efficiency. The mills are worked continuously on a 24-hour day basis when in operation, and in general it seems that around 17 tons of fruit per day can be handled with maximum efficiency. Assuming an oil yield of 17 per cent. of the weight of the fruit (which is achieved in efficient mills) this is equivalent to a production rate of about 33 gallons of oil per hour. This agrees well with figures given me for the rate of production. Much higher handling rates are reported in some cases—up to 30 and 45 tons of fruit per day, but these are admitted to be accompanied by low efficiency of extraction, with yields of only 12 per cent., or less (by weight). In cases of efficient extraction the residual cake should not contain more than 5 to 6 per cent. of oil. At Gainesville charges of from $7·00 to $9·00 per ton of fruit are made to growers for milling their crop, and in addition to the oil they retain the ground hulls and the residual cake.

Experimental work on the possibilities of solvent extraction is being carried on by the United States Bureau of Chemistry, working in conjunction with the Department of Agriculture at Bogalusa. Hitherto, oil produced by solvent extraction has been unsatisfactory, with a tendency to solidify on keeping. It seems unlikely that solvent extraction will ever replace the expeller completely, for some mechanical treatment will always be necessary in order to break up the cells of the nuts so that the solvent can reach the oil. Given a satisfactory solvent, however, the speed of production could be greatly increased by putting the material rapidly through an expeller for partial extraction and then treating the residue with solvent to obtain the remainder of the oil. Higher yields should also be attainable in this way.

The state of dryness of the fruits has been found to have some influence on the yield of oil obtained in the ordinary expeller process. It is often considered that the fruits should be quite dry before handling. Mr. Lamont Rowlands has, however, obtained slightly better yields by taking fruits that are not quite dry, but drying the *meal* further before it enters the expeller press. This is effected by means of an additional steam coil which heats the meal on its way from the grinder (subsequent to hulling) to the steam jacket of the expeller.

TRADE ASPECTS OF THE TUNG OIL INDUSTY

The domestic tung oil industry of the United States is still in its infancy as far as production is concerned. In alternate years almost the entire crop has been lost through frost damage, and even the highest production ever attained (1938) did not reach 4 per cent. of the factory consumption in the United States for that year. The following figures are supplied by the United States Department of Commerce, Bureau of Foreign and Domestic Commerce [4].

Tung Oil Statistics (in millions of pounds)

	1933.	1934.	1935.	1936.	1937.	1938.
United States factory consumption	92	106	114	108	120	87
United States imports	119	110	120	135	175	108
United States production	0	½	0	2	½	3
Chinese exports	166	138	163	191	226	153

From this it will readily be understood that no special marketing organisation is necessary to deal with the domestic production. The grower simply sells directly to the consumer, or in some cases he may sell his crop to the mill owner, who in turn deals direct with the oil produced.

The trade with China is now greatly complicated by the Sino-Japanese hostilities, but the market has always been subject to fluctuations. If the Japanese advance reaches the Western Provinces where most of the tung is produced many of the trees may be destroyed under China's "scorched earth policy" and a very serious shortage of the oil result. In addition, the colour and general quality of the Chinese oil are below the standards of that produced in the United States, owing to the primitive methods of extraction employed, for the people still cling to the crude stone grinding mills and wedge presses carved out of tree trunks, that have been used for centuries. One firm attempted to establish a small pressing plant at the port of shipment and installed modern machinery, but the local opposition to the scheme was such that it was found impossible to get supplies of fruits or nuts. The adulteration of the oil that was formerly so prevalent has at least been largely stopped by the introduction of testing to comply with definite standards before the oil is shipped.

Owing to the uncertainty and small volume of the American

crop, and to the difficulties mentioned above experienced in the trade with China, the view that any new source of the oil would be welcomed by the trade seemed general among the shippers and dealers with whom I came in contact. A problem to be faced by one firm of varnish manufacturers serves to illustrate this. The firm had recently tried using the home-produced oil in their manufactures and as a result had been successful in making a lighter and clearer varnish. The following year the American tung crop was ruined by frost damage and only Chinese oil was available, so that it was impossible to repeat the clear varnish owing to the darker colour of the Chinese oil. Maintenance of a constant standard has now become so important in industry that, rather than turn out a superior product which cannot be repeated every year, the firm has now returned to using the darker-coloured Chinese oil even when American oil is available.

Another result of the uncertainty of tung oil supplies has been the investigation of possible tung replacements such as treated castor oil, etc., but it is so far doubtful to what extent these can truly replace tung. A paper on this subject was read by Dr. H. A. Gardner at the Annual Convention of the National Paint, Varnish and Lacquer Association held in San Francisco in November 1939 [2].

The actual shipment of the oil from China has been largely modernised. It was formerly transported down the Yangtse in small lots by junks and shipped across, mostly to Seattle, in barrels or drums. The "mechanisation" of the Yangtse River brought bulking of the oil at collecting centres upstream, particularly Chungking, and steam transport down the river. For a number of years nearly all the oil has been shipped in bulk in tankers, and now nearly 95 per cent. of the imports come to New York and other ports on the Eastern seaboard.

At the outbreak of hostilities large quantities of the oil destined for the United States were held up at Hankow, but it is understood that the Japanese authorities have arranged to release these stocks where they had already been purchased before Hankow was occupied. Oil has since been shipped by the Chinese from Hong Kong, and other South China ports, from French Indo-China, and it is understood that a road is in course of construction by which it could be exported through Burma. The terrain and climatic conditions in South-Western China are such, however, that some of the importers with whom I spoke were sceptical about the success of this project.

Under the emergency conditions the Chinese Government now holds a virtual monopoly of the oil. A loan of $25,000,000 was made by the United States Government to China and all the oil imported is now handled by the Universal Trading Corporation, a Chinese organisation in New York that has been established as a result of this loan. The various firms which formerly imported the oil now have to obtain their supplies from the Corporation,

but they otherwise carry on as before, selling direct to consumers as a rule, though small quantities of the oil (less than one tank car load = 8,000 gals.) are often sold through brokers. Rules governing the purchase and sale of the oil have been drawn up by the Oriental Oils Association, New York [11]. There is no import duty on the oil, so that the United States Customs Authorities rarely have occasion to examine it, but I understood that the procedure of sampling and the instruments used are similar to those employed for other fatty oils.

LIST OF PUBLICATIONS

1. "Tung Oil Culture." By H. A. GARDNER and P. H. BUTLER. *Special Circular* (1937), Scientific Section, National Paint, Varnish and Lacquer Association.

2. "Oils for Quick Drying Finishes, a Discussion of Tung Oil Replacements." By H. A. GARDNER. *Special Circular* (1939), Scientific Section, National Paint, Varnish and Lacquer Association.

3. "Tung Oil." By C. C. CONCANNON. *Trade Promotion Series No.* 133 (1932), U.S. Department of Commerce.

4. "Tung Oil—Synopsis of Information." By E. C. Wood (1939). U.S. Department of Commerce.

5. "The Tung-Oil Tree." By W. NEWELL, H. MOWRY and R. M. BARNETTE (1930). Revised by A. F. CAMP and R. D. DICKEY. *Bulletin No.* 280 (1935), University of Florida Agricultural Experiment Station.

6. "A Preliminary Report on Zinc Sulphate as a Corrective for Bronzing of Tung Trees." By H. MOWRY and A. F. CAMP. *Bulletin No.* 273 (1934), University of Florida Agricultural Experiment Station.

7. "A Preliminary Report on Frenching of Tung Trees." By W. REUTHER and R. D. DICKEY. *Bulletin No.* 318 (1937), University of Florida Agricultural Experiment Station.

8. "The Effect of Root-Knot Upon the Subsequent Growth of Tung-Oil Seedlings." By R. D. DICKEY and H. MOWRY. *Proceedings of the American Society for Horticultural Science*, 1938, **36**, 389-392.

9. "The Tung-Oil Tree in Georgia." By H. L. COCHRAN. *Circular No.* 108 (1936), Georgia Experiment Station.

10. "Oil Variations of Tung Trees." By T. A. PICKETT and W. L. BROWN. *Circular No.* 115 (1938), Georgia Experiment Station.

11. Rules to Govern Purchase and Sale of China Wood Oil and Perilla Oil. Oriental Oils Association. Adopted 1928, Amended 1930 and 1935.

Description of Illustrations

Plate I, fig. 1—Seedling of "low-headed" type at Lamont, showing characteristic well-spaced branching. This plant and the one shown in Plate I, fig. 2, illustrate the growth made in one season from seed sown directly in the field.

Plate I, fig. 2—Seedling of "high-headed" type at Lamont, showing crowded branching at the top of the year's growth.

Plate II, fig. 1—Fruit of "cluster" type of *Aleurites fordii*. The number of fruits in a cluster may be anything from two to seven or eight.

Plate II, fig. 2—Fruit of "single" type of *Aleurites fordii*. The bud which will continue the growth of the branch next year can be seen at the base of the fruit-stalk.

Plate III, fig. 1—"Moorei" variety of *Aleurites fordii*—head of a seedling showing the distortion of the leaves. The appearance of these plants suggests virus infection, but the deformity is hereditary.

Plate III, fig. 2—"Carriage-wheel" branching. An adventitious branch that has broken at the crotch is also visible at the base of the trunk.

Plate IV, fig. 1—Plantation of single-trunk trees at Gainesville. The trees are about 9 years old and planted on the square with a spacing of 26½ × 26½ ft.

Plate IV, fig. 2—Bole of multiple-trunk tree at Lamont. These trees were planted out in 1932 after one year in the nursery.

Plate V, fig. 1—Patch-bud about three weeks after insertion. The elastic bands holding the patch have been removed.

Plate V, fig. 2—Spring-budded trees, 12 ft. high, after one season's growth from the buds.

NOTES

Thespesia lampas fibre.—The search for a substitute for jute has been going on for very many years, but in no case has a suitable fibre yet been found which has been able to compete with jute in the world markets, although some, such as *Urena lobata* in Cuba, have found a limited local use. One of the latest of these fibres to attract attention is that derived from *Thespesia lampas*, a shrubby plant belonging to the Malvaceæ and occurring in the tropics of Eastern Asia and Africa. This fibre has long been used by the natives for rope-making and similar purposes, but tests made in the Philippine Islands indicated that rope made from strips of *T. lampas* bark was inferior in strength to that prepared from other materials available there (*Phil. J. Sci.*, 1919, **16**, 605).

Considerable attention has recently been devoted to the possibility of growing the plant in Indo-China as a source of fibre to replace jute. That colony imports annually about 30,000 metric tons of jute sacks and 1,000 tons of cordage, so that there would be considerable local outlet, provided the quality proved satisfactory. According to an article in *L'Agronomie Coloniale* (1939, **28**, No. 257, 161-173) *T. lampas*, which is known locally as Polompom, grows spontaneously on alluvial soils in the neighbourhood of water courses and ponds, over a considerable range of altitude. Like jute it thrives best on sandy-clay or clay soils, but is readily adaptable to other soil conditions, provided there is sufficient moisture present. An annual rainfall of around 70 in. is desirable.

In the wild state the seeds germinate with the first rains and make rapid growth, so that they are sufficiently large to withstand the floods occurring from time to time at the height of the rainy season. The plants will not grow, however, in swamps which are permanently flooded. The mature stems are commonly destroyed by the brush-fires occurring in the dry season, but the seeds remain uninjured. Indeed, it is said that the fires have a beneficial effect in helping to crack the hard shell of the seeds. The plant has remarkably good regenerative power in throwing up new shoots from the stool when cut back or damaged, a factor of considerable importance from the point of view of fibre production.

The yield of fibre from wild stands is naturally subject to wide variation. Figures of from 180-280 lb. per acre of dry fibre have been estimated, and it is claimed that this yield could easily be tripled by improving the wild stands or by establishing plantations. In a note on the fibre published in the *Bulletin Économique de l'Indochine* (1939, **42**, No. 5, 1061) it is stated that a yield of dried fibre of about 2,000 lb. per acre could be expected from a plantation, beginning from the second year. The stems are harvested at the end of the rainy season and the new shoots growing up from the stool reach a height of 8 to 10 ft. the following year.

The native method of obtaining the fibre is by retting in running water for a period of from 2 to 4 weeks. Green bark should be retted immediately after cutting, but stripped, dried bark from which the epidermis has been removed may be kept for a considerable time before retting.

The Imperial Institute had occasion recently to examine a sample of the fibre from Indo-China. This consisted of bundles of prepared fibre, in the form of strands about 4½ ft. to 5½ ft. in length. The fibre was of a fairly uniform, rather dark greyish-brown colour, and possessed moderate lustre. On the whole the sample was fairly well prepared, but some of the strands were gummy and the fibre filaments consequently not properly separated. The fibre generally was harsher than jute (*Corchorus* sp.) and except for its dark unsatisfactory colour it more resembled "Roselle" fibre (*Hibiscus sabdariffa*). The strength of the material was uneven and some of it was decidedly weaker than well-prepared jute.

A portion of the sample was submitted to a firm of merchants in London who furnished the following observations:

"We have examined the sample and beg to report as follows: 5 ft., brown to dark greyish fibre, fairly clean with some lustre, but the preparation could be improved and the fibres further separated. The fibre is generally rather harsh, brittle and lacking in spinning quality. Improved preparation should make it more spinnable, but might further impair its strength. Jute substitutes, to command a good price, should be of light, practically white colour. A dark substitute fibre would only sell if relatively cheap compared with a Calcutta grade of similar colour. Unless the colour could be improved it might be difficult of sale. We suggest a value about equal to that of Calcutta Hearts, say £22 per ton. A light-coloured whitish or creamy fibre of similar nature might be worth £30 to £32 per ton."

The results of examination and the foregoing commercial valuation indicate that the fibre represented by the present sample, which is of very satisfactory length, would be readily saleable as a jute substitute if it were suitably prepared and could be offered in commercial quantities at a competitive price.

Vanilla in Uganda.—The possibilities of growing vanilla in Uganda was first seriously brought to the notice of the Imperial Institute in 1932 when samples of pods produced on an estate at Entebbe were submitted for examination by the Department of Agriculture. They proved to be of low value, compared with standard grades of commercial vanilla pods, and advice was furnished on methods of preparation with a view to improving the quality of the product. The following year a further sample of pods grown at Entebbe was received and this proved to be much superior both in appearance and odour and it was clear that consignments of similar character would be readily saleable in London.

Since that date Uganda vanilla has appeared from time to time on the London market and at the auction sales in June 1939 parcels of vanilla from Uganda and the Seychelles realised practically the same prices. The following details of the sale are recorded in *The Chemist and Druggist* for July 1, 1939 :

	Length.	Price. Per lb.
SEYCHELLES		
"First" fair, not crystallised, fair flavour	7 in. and 8 in.	20s.
,, ,, ,,	6 in. ,, 6½ in.	20s.
,, ,, ,,	4 in. ,, 5 in.	20s.
"Splits," part dry, foxy to fair brownish	3½ in. ,, 6½ in.	16s. and 17s. 6d.
UGANDA		
"First," also rather hard "First" or good "Second" crystallising, good flavour	6 in. ,, 7 in.	20s.
,, ,, ,,	5 in. ,, 6 in.	20s.
,, ,, ,,	4½ in. ,, 5½ in.	19s. 6d.
,, ,, ,,	3½ in. ,, 5 in.	19s.
"Splits," dry reddish	4 in. ,, 7 in.	16s. 6d.
Part split and cuttings, loose, dry reddish	—	13s.

At the request of the Imperial Institute the Director of Agriculture, Uganda, kindly furnished the following account of the Uganda industry which had been written by Mr. A. S. Thomas, Botanist in the Department.

"Vanilla plants were first introduced into Uganda from Ceylon by the Botanical, Forestry and Scientific Department in 1912 and were established in the Botanic Gardens ; the vines grew well, but for many years little interest was taken in the crop. A small plot was planted on the Kampala Plantation in 1920 but was not very successful as the small trees of *Jatropha curcas* on which the vanilla was supported did not give sufficient shade. The vines therefore were transferred in 1935 to a more shady plot of *Gliricidia sepium* under which they have flourished, growing quickly, while some of the older plants have flowered well. Although there is a record only of the introduction of *Vanilla planifolia*, yet it is now evident that *Vanilla pompona* at some time was brought into the country, for some of the vines at Kampala belong to this species—they differ from *Vanilla planifolia* in their very robust growth, large yellow flowers and short wide triangular pods, which are of little commercial value. As the Kampala Plantation is being given up, steps are being taken to establish a small plot of vanilla in the Botanic Gardens, Entebbe.

"Commercial planting of vanilla in Uganda was commenced by Mr. Mirza, an Iranian, a few years ago on an estate at Entebbe ; the work was financed by the H.M. Syndicate, who were the pioneers of large-scale planting of coffee and rubber in Uganda. Recently, the estate has been taken over by the H.M. Syndicate ; Mr. Michael Moses, M.B.E., one of the partners of the syndicate, stayed for a

month in the Seychelles in order to study the methods of production there and his knowledge has been applied to the development of the plantation.

"The climate of Entebbe is equable, the average rainfall being about 60 in., well distributed throughout the year; the temperature shows little seasonal variation, the average maximum being about 78° F. and the average minimum about 63° F. The estate is in a sheltered situation, close to Lake Victoria; much of it had been planted with Para rubber, which had been neglected and had reverted to semi-forest conditions, and the shade has been thinned to give the density suited to the vanilla. The degree of shade is most important in the cultivation of vanilla—if it is too light, the vines suffer from exposure and if it is too dense the vines do not flower well. All available vegetable matter is used to mulch the roots of the vanilla.

"Constant attention has been given to the vines in training, topping and pruning; weak vines are layered to give better root systems for good crops are produced only on vigorous plants. When the vines are cut back, all good stems are used for propagation; there is now a total of about forty thousand plants on the estate—the number would have been greater had growth not been repressed by the unusually dry weather of the last two years (rainfall at Entebbe in 1938 was 17 in. below the average).

"It has been found that Africans may easily be trained to carry out the work of fertilisation by hand—when there is a flush of flowers a good man will attend to as many as three thousand per day; this work should be done as early as possible each morning. In Uganda about ten months must elapse between fertilisation and the maturing of the pod; this is much longer than the period, four or six months, which is required in other countries.

"The methods of curing follow the usual practice: the best results are obtained by immersing the pods for about five seconds in boiling water, for long immersion causes the pods to become reddish. The actual curing between blankets may take up to a month in damp weather; when the process is finished the pods are sorted, bundled, and packed in tins lined with grease-proof paper. If the tins are exported by parcel post, they are sown up in hessian cloth but if they are sent by freight they are packed in boxes.

"The results obtained have been so promising that other planters are becoming interested in the crop; but it appears that vanilla is not likely to be a commercial success in any but the moister, warmer parts of Uganda and under conditions where very careful attention is given to the problems of cultivation and of preparation."

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

Insect Pests

Malaya.—The following particulars of investigations on insect pests of various crops are contained in the report of Mr. G. H. Corbett, Senior Entomologist, for the half-year July to December 1939.

Rice.—Experiments with a view to ascertaining the agent responsible for the non-setting of seed have been delayed owing to a prolonged drought.

Experiments with derris against padi insects in the field are in progress.

Conditions of storage of rice and padi are under investigation. The treatment of stored rice with finely divided chalk as a preventive against insect attack has proved unsuccessful.

The most suitable fumigant for treating infested rice and flour is being sought. Promising results have been obtained with choloropicrin but there is some doubt about the residual effect on the product.

Vegetables.—Spraying cabbages for the control of Plutella has not given good results with any insecticide used, but a derris spray on radishes, to the leaves of which the spray sticks well, gave 100 per cent. control of this insect. Further trials, using inert spreaders, are in progress.

Fruit Flies.—Investigations are in progress on the control of Trypetidæ (fruit flies). These comprise breeding of the species of known economic importance for the purpose of ascertaining the duration of their life-cycles, experimental work on control measures and the collection of data regarding the species of fruits, both wild and cultivated, which are liable to attack.

Pineapples.—*Pseudococcus brevipes* Ckll. has continued to receive attention. While the initial symptoms of mealy-bug wilt are evident on pines growing in peaty areas there is no evidence to show that this wilt is of importance in such areas. Indeed, field observations indicate that on peaty areas, pines rarely develop the advanced symptoms of mealy-bug wilt such as are evident on quartzite soils. The importance, however, of mealy-bug wilt to pines on the latter soils has not yet been determined, but, even if its importance were established, the control of *Pseudococcus* in the field by effective insecticides may not prove to be economically justified.

Bananas.—Further consignments of Dactylosternum beetles

to be used against the banana weevil borer, *Cosmopolites sordidus*, have been despatched by air to Jamaica and Queensland. The consignment for Jamaica arrived at Southampton on September 3, while that for Queensland was dispatched in October.

INSECTICIDES

Derris

Malaya.—The following statement is taken from the report of Mr. T. A. Buckley, Acting Senior Chemist, for the period July-December 1939.

Following on the investigation regarding the behaviour of clonal types of *Derris malaccensis* var. *sarawakensis* and *D. elliptica*, Sarawak creeping, under field conditions in which such wide variations in toxic content between individual plants were found (*vide Malayan Agricultural Journal*, August 1939), an experiment was laid down in the General Nursery at the Central Experiment Station with these two species. The object was to ascertain whether an average high toxic content would be maintained starting with mixed cuttings derived from parent plants with roots of known high toxic content.

Mixed populations of the following species were established, the limits of ether extract, calculated on a moisture-free basis being as follows :

	Per cent.
(*a*) *Derris malaccensis* var. *sarawakensis* .	33–27
(*b*) ,, ,, ,, ,, .	27–25
(*c*) *Derris elliptica*, Sarawak creeping .	29–26

The plants were spaced 3 ft. × 3 ft. Average samples of root have been drawn for analysis at 3 monthly intervals commencing at 15 months. The results are shown below :

Age of plants. *months.*	Weight of Air-dry Marketable Root per plant. *ozs.*	Rotenone. (Moisture-free basis). *Per cent.*	Ether-Extract. (Moisture-free basis). *Per cent.*	Proportion of Rotenone to Ether Extract. *Per cent.*
(*a*) *Derris malaccensis* var. *sarawakensis*, ether extract 33–27 per cent.				
15	3·43	6·05	28·56	21·2
18	3·43	5·13	28·59	18·1
21	3·93	5·00	27·05	18·3
(*b*) *Derris malaccensis* var. *sarawakensis*, ether extract 27–25 per cent.				
15	3·90	6·07	28·06	21·6
18	2·59	4·83	27·76	17·5
21	4·20	4·52	26·91	16·9
(*c*) *Derris elliptica*, Sarawak creeping, ether extract 29–26 per cent.				
15	1·97	8·48	27·61	30·8
18	1·62	8·27	30·72	27·3
21	1·99	8·32	30·05	27·6

Compared with the parent plants, the low yields of root, particularly in the case of *D. elliptica*, Sarawak creeping, are surprising and disappointing. The lower yields may be due to the much closer spacing of the plants, 3 ft. × 3 ft. compared with 8 ft. × 5 ft. Further, in the case of a species with a pronounced prostrate habit, such as *D. elliptica*, Sarawak creeping, close spacing may well restrict the overground development of the plant with consequent reduction in underground root growth. The toxic contents are most satisfactory, particularly the high rotenone content of the *D. elliptica*, Sarawak creeping. An experiment has, therefore, been instituted to test the influence of spacing both on yield of root and toxic content.

Beverages

Coffee

Malaya.—Mr. T. D. Marsh, Acting Senior Agriculturist, in his report for the half-year July-December 1939, states that an experiment has been laid down to test the effect of mulching on coffee. Two species are under experiment, *Coffea liberica* and *C. robusta*. After 12 months a marked improvement in the health of the mulched bushes of both species is noticeable, manifested both by increased vigour of the bushes and colour of the foilage.

This increased vegetative response cannot yet be correlated with an increased crop production. There are no significant differences between the yields of cherries on the mulched and control plots. The experiment is being continued.

Sugar

Cane

St. Kitts-Nevis.—The Agricultural Superintendent reports that during the period July-December 1939, the Agricultural Department laid down 26 variety, manurial and cultural experiments with sugar cane in co-operation with the Sugar Cane Investigation Committee. The experiments were planned by Mr. P. E. Turner, M.Sc., F.I.C., Adviser in Sugar Cane Experiments to the Commissioner of Agriculture.

During this period cuttings of 14 new sugar cane varieties were received from the Central Cane Breeding Station at Barbados through the Plant Quarantine Station in Trinidad for multiplication and trial. In all the Department received during the year from the Barbados station cuttings of 24 new cane varieties. All this new planting material is being multiplied as rapidly as possible for the purpose of obtaining sufficient planting material for variety trials.

Fodders

Malaya.—According to the report of Mr. T. D. Marsh, Acting Senior Agriculturist, for the half-year July-December 1939, a

randomised manurial experiment has been laid down at the Central Experiment Station, Serdang, on two different types of land to test the effects on yield and composition of Napier grass (*Pennisetum purpureum*) and Merker grass (*P. merkeri*) with varying intervals of cutting and using increasing applications of cattle manure. One type of land may be described as sloping land of medium texture, the other is flat light land of poor fertility. The rates of application of cattle manure are 5, 7½, 10 and 15 tons per acre per annum, the intervals of cutting 6, 8 and 10 weeks, respectively.

The results for the first six months of cutting are summarised below, the particulars relating to composition being taken from the report of Mr. T. A. Buckley, Acting Senior Chemist.

Species of Grass.—There was no appreciable difference in yield between the two species, the average for Napier grass being 6·8 tons per acre, as compared with 6·6 tons per acre for Merker grass.

The Napier grass showed a slightly higher crude protein content and a slightly lower crude fibre content, as the following figures, calculated on a moisture-free basis, for grass cut at six weekly intervals show:

	Crude Protein. *Per cent.*	Crude Fibre. *Per cent.*
Napier grass	9·7	32·0
Merker grass	9·4	33·4

Soil.—The yields on the flat light land were slightly higher than those on the sloping land of medium texture. The type of soil had no influence on the composition of the grasses, except for a slightly higher average phosphorus content in the case of the flat land of low fertility.

Interval of Cutting.—The approximate yields for the three cutting intervals were 6·3, 7·0 and 8·2 tons per acre respectively. Increases in yield for 8 and 10 weeks intervals over a 6-weekly interval of cutting were 11 and 30 per cent. respectively.

As regards composition the effect of increasing the cutting interval was to increase the crude fibre content slightly and to decrease the crude protein content. There was also a tendency for the lime and phosphorus content to decrease with increase in interval of cutting. This was more noticeable with the grass planted on the flat land of low fertility.

Manurial Treatment.—There was a slight increase in yield as a result of an increased manurial dressing. If yields are plotted against manurial dressings an approximately straight line is obtained which indicates that a basal yield of 4·2 tons per acre could be obtained without any manure, an increase of 0·26 tons of grass being obtained for every ton of cattle manure applied. Increasing application of cattle manure had no influence on the chemical composition of the grass.

Owing to the disturbing influence of varying rainfall on yields of fodder grasses a randomised trial is in progress at Serdang with Napier grass (*Pennisetum purpureum*) and Guinea grass (*Panicum maximum*) on irrigated and non-irrigated land. In the case of the irrigated plots the water is directed along an open concrete pipe laid along one side of the area under experiment and then into shallow earth drains between the rows of grass. Water to the irrigated plots is supplied at a rate equivalent to a rainfall of 2 in. per week.

The results to date indicate that in spite of the improved general appearance of irrigated over non-irrigated grass there is nothing in chemical composition to distinguish them.

Oil Seeds

Coconuts

Malaya.—Mr. Gunn Lay Teik, Acting Chemist (Coconut Products), in his report for the half-year July to December 1939, gives the following particulars of investigations on copra drying.

As mentioned previously (this Bulletin, 1939, **37**, 384) a slight alteration in the design of the roof of the small copra cabinets has profoundly enhanced their performance and somewhat modified their method of operation. It was found that, after the attap leaves constituting the roof of the original type of new kiln dried out, the roof consolidated, so that the hot moisture-laden air leaving the copra was no longer able to percolate so freely through to the outside. After experimenting with various types of roof and eave openings, a jack roof of suitable design was evolved. This naturally added a little to the expense and the trouble of erecting these new copra cabinets but this was compensated for by improved heat efficiency and greatly increased nut capacity per unit area of grill.

Several cabinets of the latest design and of ascending size erected at the Copra Demonstration Centre, Port Swettenham, have been subjected to systematic trials to determine the most efficient method of operation. Some of the smaller cabinets are constructed almost wholly of materials which the native smallholders can readily obtain at very low cost, such as attaps and nibong and bakau poles. The larger cabinets are constructed of more permanent materials such as wooden planks, expanded metal, and galvanised iron ; they operate nevertheless on the same principle as the smallest of the series.

As a result of a number of trials with three of these cabinets of ascending capacity, it is now possible to lay down simple conditions for the operation of these cabinets for the production of high-grade copra.

For estates where a much greater capacity is required, it is only necessary to increase the number of chambers in the kiln.

A large four-chambered kiln designed on the same principles and having a capacity of 4,200-6,000 nuts has undergone trials. It has been found that, except for slight modifications as regards firing, such large multi-chambered kilns can be operated with as little attention as the smallest in the series to produce a high-grade product. These larger kilns represent a very substantial saving in cost of construction and are more efficient and simpler in operation than the present brick kilns used on many estates.

With any of these new cabinets high-grade dry copra can be easily produced inside an overall time of 48 hours, which is less than the time at present necessary to obtain dry copra on existing kilns used on estates and smallholdings.

Oil Palm

Malaya.—Mr. T. D. Marsh reports that experiments have been carried out regarding the effect on viability of seed stored for periods up to 12 weeks before planting. Two methods for cleaning the fruit were used. In the first method the pericarp was removed by paring with a knife, in the second the pericarp was softened by soaking the fruit in water for 4 days and removed by light pounding of the sodden fruit with a wooden pole. The seeds were dried before being stored.

The results showed that viability was not impaired by storing for periods up to 12 weeks and further that seed cleaned by rotting the pericarp gave just as good germination as that cleaned by paring off the pericarp with a knife.

Germination of seed planted in sand beds has been compared with that for seed planted in beds containing a layer of pericarp refuse from the factory 2 in. thick, on which the seeds are placed, and covered with a layer of ordinary soil 1 in. thick. All beds were left unshaded. Initial germination was better in the pericarp refuse than in sand, but 60 per cent. germination was obtained after 23 weeks in both media, the final figures being at 36 weeks 83 per cent. for sand and 63 per cent. for the pericarp refuse. The figures indicate that germination in sand beds is more satisfactory than in beds composed of pericarp refuse and earth.

A disadvantage of the pericarp refuse method is that the root system of the seedling is apt to become entwined with the fibrous pericarp residue, thus rendering it difficult, when transplanting, to lift the seedling without damage to the curved radicle. Seedlings germinated in sand beds invariably possess a straight radicle and are therefore easy to lift without damage.

A randomised experiment has been laid down at the Central Experiment Station, Serdang, to test the effect on yield of fruit bunches of encouraging a controlled natural undergrowth under mature oil palms. The palms, which were planted in 1922, were

15 years old when the experiment was started. The area was clean weeded until 1932 when the natural undergrowth was allowed to establish itself. The undergrowth was kept in check by occasional slashing and by weeding narrow strips between the palms. This procedure was followed until 1937 when the experiment was commenced.

There are three treatments: (*a*) clean weeding, (*b*) slashing, and (*c*) controlled natural undergrowth. In the case of treatment (*b*) the undergrowth between the rows of palms is kept in check by slashing close to the ground every month. As regards treatment (*c*) selective weeding of the natural undergrowth is practised. The undesirable plants are removed and those remaining are controlled by cutting back to a height of 4 to 5 ft. twice a year. Among the plants which have been cut out may be mentioned bracken, stag moss, several species of grasses and maiden-hair creeping fern.

The yields of fruit bunches were unaffected during the first year. During the second year treatment (*a*) gave an increase of 8 per cent. over treatment (*b*) and 19 per cent. over treatment (*c*). These differences during the first 6 months of the third year were even more marked, treatment (*a*) giving an increase of 28 per cent. compared with treatment (*b*) and 44 per cent. compared with treatment (*c*).

The experiment must, however, be continued for some years before final conclusions may be drawn.

DRUGS

Cinchona

Malaya.—Mr. A. Thompson, Senior Plant Pathologist, in a report for the half-year July-December 1939, states that a disease affecting *Cinchona ledgeriana*, and to a lesser extent *C. succirubra*, appeared in trial plots of 9-10 year old trees growing at Cameron Highlands at an elevation of 4,800 ft. The disease, which has occurred only in trees growing on an area of shallow, black, top soil, containing sand pockets, overlying a stiff granite sub-soil, appears to be a form of basal stem canker in association with a decay of portion of the root system. The fungi associated with the decay of the tissues are *Phytophthora cinnamomi* Rands and a species of Phomopsis.

FORESTRY

GENERAL

Trinidad.—The following information is taken from the two half-yearly news letters covering the year 1939, prepared by the Conservator of Forests.

Silviculture.—The annual area to be planted under teak in 1940 will be increased from 140 to over 400 acres. This is a contribution of the Department to the "grow more food" campaign, since a

useful acreage will be provided for the growing of ground provisions in conjunction with teak.

Despite an unusually dry "wet season," regeneration operations during the year were for the most part very successful.

Soils.—The proposed expansion of the silvicultural programme naturally calls for adequate information on the soils of the areas to be dealt with. Fortunately the soil survey of Trinidad under the supervision of the Soil Department of the Imperial College of Tropical Agriculture has made rapid progress, and the Forest Department has now available excellent soil maps on a scale of 12 chains to 1 in. of all the Forest Reserves most suitable for silvicultural development. The better type soils suitable for teak are clearly shown on these soil maps, and approximately 32,000 acres are available for this species. The soils of Trinidad are very diverse, the majority being definitely of a rather poor quality. The soil survey has shown clearly the causes of such failures in teak plantations as have occurred in the past: fortunately these failures have formed a very small proportion of the total area on which teak has been planted. The improvement felling technique, with or without supplementary artificial regeneration, has been considerably improved and this technique will be applied to increasing areas of poor quality soils.

Utilisation.—A teak wood block floor for Government House, prepared from thinnings from a 25-year-old teak plantation and covering an area of 3,000 sq. ft., has been laid in a herring-bone pattern. Although this type of work was novel to the local workmen, they turned out a very creditable floor indeed. Considerable interest has been aroused in this form of flooring, and later in the year another teak wood block floor prepared from thinnings from the 25-year-old teak plantations and covering an area of approximately 500 sq. ft. was laid in a private dwelling house.

The Forest Department satisfactorily seasoned 1,000 board feet of a suitable local wood, which was sold to a floor block manufacturer at a satisfactory profit. It is hoped to season larger quantities of suitable local woods departmentally and thus provide a regular supply to the manufacturers.

Research.—A fourth examination of the timbers undergoing durability tests was completed during the first half-year. The termite population was found to have been further reduced and fungus continues to be the major agent causing damage. Coptotermes have completely disappeared, but Microcerotermes, not observed at previous examinations, were found to be attacking certain of the pieces.

In a fifth examination of the timbers completed during the second half-year, the reduction in the termite population was found to have continued. A species of termite, *Termes hispaniolæ*, not hitherto found in these graveyard tests, was recorded from the Southern Watershed Reserve.

Creosoted roundwood teak fence posts, mora and Western red cedar have been added to the species under test; various species treated with metallic napthenates have also been included.

Some interesting tests as to the resistance of teak and certain local woods to dry wood termites have also been inaugurated. So far it has not proved possible to induce these termites to attack the heartwood of teak.

Resins

Cyprus.—The following particulars relating to the tapping of Aleppo pine have been received from the Conservator of Forests.

The resin tapping experiment on immature Aleppo pine at Halevga was continued in 1939 for the third season, the French system of tapping being employed. The result was that from 70 trees tapped, 68 lb. of resin were extracted, i.e. nearly 1 lb. per tree.

A large-scale resin tapping experiment on 500 mature Aleppo pine trees was initiated at Stavros in the Paphos forest. The broad blaze system of tapping (American system) is being tried here, three blazes in tiers being put on all stems, with the object of tapping the trees to death prior to felling. From 431 trees tapped, 1,064 lb. of resin were extracted, an average of 2·47 lb. per tree. Though the results so far obtained are not very encouraging, it is still too early to say whether a local resin tapping industry could be economically established in Cyprus. The experiments are being continued in 1940.

Distillation tests by the Utilisation Officer have yielded turpentine oil of satisfactory quantity and quality. The rosin left after filtering to remove foreign matter proved of darker colour than normal. The Utilisation Officer attributes the unsatisfactory colour to impurities, especially insects in the distillate, and is now testing whether filtration of the crude resin prior to distillation improves the colour of the rosin.

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Errata.—Bulletin, Vol. XXXVII, No. 4, 1939, p. 586, line 21, and p. 590, lines 25 and 47, for *N.Z.* read *Aust.*

IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 9

(November and December 1939)

Prepared in collaboration with the Imperial Institute of Entomology and the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

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The Constitutents of Certain Species of *Helenium.* Part II. Tenulin. By E. P. Clark. *J. Amer. Chem. Soc.,* 1939, **61,** 1836. *Helenium autumnale* is stated to have possiblities as an insecticide.

Note.—The reference in brackets—*R.A.E.,* etc.—which appears after certain items of the bibliography indicates the part and page of the *Review of Applied Entomology* in which an abstract of the publication mentioned can be found.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

LAND DRAINAGE AND RECLAMATION. By Quincy Claude Ayres, C.E., and Daniels Scoates, A.E. Second Edition. Pp. xi + 496, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1939.) Price 26*s.*

This book deals in a very practical manner with the many and varied problems covered by the title, giving information that will be of real assistance in tackling them. It should therefore prove a valuable acquisition for those concerned with such problems, particularly the farmer and the agricultural student.

In the present volume, which is the second edition of a work first appearing in 1928, there is no great change in the arrangement of the subject matter, but the text has been brought up to date throughout. Two further chapters have been added to the section on the control of erosion, a subject on which one of the authors (Mr. Ayres) has published a detailed treatise in (see this BULLETIN, 1938, **36**, 130).

The book contains numerous illustrations and diagrams; references are given at the end of each chapter, and there is an appendix containing useful tables and a good index.

GROWING PLANTS WITHOUT SOIL. By D. R. Matfin, M.A. Pp. 137, 8½ × 5½. (London: E. & F. N. Spon, Ltd., 1939.) Price 10*s.*

This book is described on the title-page as the A.B.C. of Plant Chemiculture, Soilless Agriculture, Water Culture, Hydroponics, Tank Farming, Sand Culture, Including Plant Growth Hormones and their Use.

The introductory chapters form a somewhat eulogistic survey of the potential value of "plant chemiculture," after which the text goes on to give some account of the methods and materials used.

A number of tables are included in the Appendix, which forms about half the book, but the information given in many of these, as well as in certain of the chapters, has little bearing on the main subject of the book. At the same time, the treatment of some of the most important aspects of water culture is so condensed as to be very sketchy and disjointed. For example, the chapter on "Chemicals needed by Plants" occupies little over a page, while nearly a page is devoted to the "Chemical Elements in the Human Body," and over six pages to a consideration of vitamins.

The glossary of scientific terms which is contained in the Appendix is not always particularly helpful, as instanced by the description of oils as "a class of nutrients composed of much carbon and hydrogen, with a little oxygen." Altogether, it is to be doubted

if this book by itself will be of very great value to the beginner in the study or practice of plant chemiculture.

THE STRUCTURE OF ECONOMIC PLANTS. By Herman E. Hayward. Pp. x + 674, 9¼ × 6¼. (New York: The Macmillan Company; London: Macmillan & Co., Ltd., 1938.) Price 22s.

This book, which has arisen from the courses on anatomy given at the University of Chicago, has as its principal object the presentation in compact form of some of the detailed work published on individual economic plants. In this it performs useful service as such work is so often scattered in different monographs, many of them on highly specialised problems or difficult of access.

The text is divided into two parts, the first being really of an introductory nature, surveying the field of plant anatomy generally and paving the way for the second part. This consists of detailed studies on sixteen selected economic plants of widely varying types and chosen as typical representatives of their plant families. Those chosen are: Maize, wheat, onion, hemp, beet, radish, alfalfa, pea, flax, cotton, celery, sweet potato, white potato, tomato, squash and lettuce.

Mention is made in the preface that the omission of important fruit crops has been made purposely as a second volume is contemplated in which these would receive special attention.

The book is admirably illustrated and contains numerous references to original papers, a useful glossary and index.

LE SOJA ET LES INDUSTRIES DU SOJA. By A. Matagrin. Pp. x + 390, 7¼ × 5½. (Paris: Gauthier-Villars, 1939.) Price 60 frs.

This book forms a thorough treatise on the soya bean with special emphasis on the industrial aspects of the crop. One chapter only is devoted to the botanical and agricultural side, but the field is well covered and there is a good list of references to the considerable literature that is already available on the cultivation of the plant.

The text begins with a historical review of the industry in different countries, and, after the chapter on botany and agriculture mentioned above, the general chemistry of the plant is outlined. Four chapters on soya bean products make up the rest of the book and are of particular value for the details on industrial processes which they include. The products are grouped as: edible products, soya bean oil, vegetable lecithin and casein. In conclusion there is a short section on the rise of the industry in France. The only important products derived from the soya bean that are not dealt with are the residual cake and meal left after oil extraction, which find a wide use as feeding stuffs.

A bibliography accompanies each chapter, and there is a detailed contents list, but it is to be regretted that a subject index has not been included as it is for reference purposes that this book will prove most useful.

FRUIT PECTINS. THEIR CHEMICAL BEHAVIOUR AND JELLYING PROPERTIES. By C. L. Hinton, F.I.C. Pp. vii + 96, $9\frac{1}{2} \times 6\frac{1}{4}$. Department of Scientific and Industrial Research, Food Investigation Special Report No. 48. (London: His Majesty's Stationery Office, 1939.) Price 1*s*. 6*d*.

This report, which is based on work carried out by the Staff of the British Association of Research for the Cocoa, Chocolate, Sugar Confectionery and Jam Trades, is primarily concerned with a study of correlations between the jelly-forming capacity of various pectins and differences in their chemical composition and behaviour. It also forms a good survey of the present state of our knowledge regarding the chemistry of this group.

The problem of correlating "jellying power" with chemical structure is still far from solved, but this work has shown where certain relationships exist and indicates also where others may be sought.

The report is necessarily of a highly technical nature, but for those engaged on the numerous problems connected with pectins it will prove extremely valuable.

DESTRUCTIVE AND USEFUL INSECTS, THEIR HABITS AND CONTROL. By C. L. Metcalf, M.A., D.Sc., and W. P. Flint. Second Edition. Pp. xvi + 981, 9×6. (London: McGraw-Hill Publishing Co., Ltd., 1939.) Price 50*s*.

A second edition of this work, first published in 1928, should be welcome in view of the rapid progress that has been made in our knowledge of economic entomology during the last ten years.

It is a book which is complete in itself, and of value chiefly to the practical farmer and the student rather than to the trained entomologist. An important feature is that the whole arrangement of the subject matter is made from the economic standpoint and too much emphasis is not put on the systematic aspects which are already dealt with in other works.

After an introductory section reviewing the importance of insects as enemies or allies of man and his activities, six chapters are devoted to giving the reader a sound general understanding of entomology. These include accounts of the morphology, anatomy and physiology of insects and a survey of their classification. The two chapters which follow on insect control, insecticides and their application should be of considerable practical value. In the remainder of the book particular insects (mostly of the United States) are discussed, grouped under such headings as "Insects Injurious to Small Grains," "Citrus Insects," and "Insects Injurious to Domestic Animals." Members of the allied groups of ticks and mites are included where they are of importance.

The text contains numerous illustrations and artificial keys for the identification of different insect pests and there is a detailed index.

MINERAL RESOURCES

ARTICLES

THE MINERAL RESOURCES OF MALAYA

By Sir Lewis Leigh Fermor, Kt., O.B.E., D.Sc., A.R.S.M., M.Inst.M.M., F.R.S.

Introduction

It is not known when Malaya first became a producer of gold and tin, but references by Arab writers to a port that may be Kedah on the west coast of the Peninsula, show that in the ninth century A.D. it was famous for tin and bamboo. Both gold and tin were certainly produced prior to the conquest of Malacca by the Portuguese in 1511, the gold causing the country to be named the *Aurea Chersonesa*, or the Golden Chersonese. In those days there was apparently overland traffic between the State of Pahang and Malacca *via* the Sungei Serting, an ultimate tributary of the Pahang river, and a tributary of the Muar river. In 1726 it was recorded that in some years more than 13,422 oz. of gold were exported, this amount being a substantial proportion of the present annual output of Pahang. The early literature contains, however, no reference to gold in Kelantan, although this is on the geological continuation of the gold belt of Raub in Pahang.

At the time of the Portuguese conquest of Malacca in 1511, a Malay tin coinage was in existence. This was suppressed by Albuquerque, who substituted a Portuguese tin coinage. At that time tin won in Selangor was taken to Malacca.

In 1641 the Dutch captured Malacca from the Portuguese, and shortly afterwards established trading stations to control the tin trade, both on the Perak river and at Kuala Selangor. Dutch records show that in 1649 the export of tin from Malacca alone was 770,000 lb., which equals 5,775 pikuls or 344 tons. In 1786 Penang was ceded to Britain, and in 1787 the annual export of tin from Perak State was some 5,000 pikuls, which had increased to 9,000 pikuls annually by 1804.

In 1818 there were estimated to be only 400 Chinese tin miners in Perak State, so that at that time the bulk of the tin must have been raised by the Malays. During the period 1818 to 1826 struggles for the possession of Perak took place between Kedah,

with Siamese backing, and Selangor, the Siamese leaving the State in 1826 in consequence of a treaty between England and Siam. Colonel Low, who visited Perak State at this time in connection with military operations, made interesting observations on the tin mines, mentioning such localities as Bidor, Chendariang, Kampar, and Batang Padang, recording also that gold was then obtained from Chekoos and in Batang Padang. Newbold, writing in 1839, gives the export of tin from Perak as 8,500 pikuls per annum, so that for a period of over forty years the output of tin appears to have been fairly constant, ranging only from 6,000 to 9,000 pikuls.

Captain T. C. S. Speedy, the first Assistant Resident of Perak, writing in 1874, states that the existence of tin in the Larut district appears to have been unknown until 1848. It was apparently a discovery in that year, by a Malay named Che Long Jaffar, of tin-ore as a black sand in a stream in Larut that led to the further development of the tin industry in Perak State, large numbers of Chinese flocking to Larut. As exemplifying the influence of this discovery of tin in Larut upon the population of the country, it should be mentioned that in 1870 no less than 40,000 Chinese were engaged in tin mining in this district. Quarrels, accompanied by much bloodshed, arose between the Chinese of two powerful secret societies, the Si Kuans (members of the Ghi Hin Triad Society) and the Go Kuans (members of Toa Pek Kong Society) over the question of the ownership of the mines, both in 1862 and again in 1872 and 1873. Petitions to the Governor of the Straits Settlements, Sir Andrew Clarke, led early in 1873 to British intervention, with the appointment of a British Resident in Perak. As a result of the pacification of the Chinese thus effected, the disputed tin mines of Larut were divided into two sections, by drawing a line through the mining country; the Si Kuans were placed in possession of the mines to the northward of the boundary and the Go Kuans of that to the south. For the northern section (Kamunting) the Malayan name of the district was retained, whilst the southern section was named by Captain Speedy "Thaipeng," or "Taiping," the modern spelling, this being Chinese for "everlasting peace," regarded by Speedy as a happy omen for the future. At the end of 1874, the population, which had fallen during the disturbances of 1872 and 1873 to only 4,000, had increased again to 33,000, of which 26,000 were Chinese.

The successful appearance of European enterprise as a factor in the tin mining industry of Malaya appears to date from the visit of a Frenchman, Monsieur J. Errington de la Croix.

This visit resulted in the introduction of French capital, so that the oldest existing European company working tin in Malaya is the Société des Étains de Kinta (Anonyme) formed in 1886. This concern was amalgamated with an earlier company, the Société des Étains de Perak, which was formed in 1884 under the management

of M. de la Croix and commenced work at Lahat and Klian Lalang, both in Kinta. Of other existing French concerns the Société des Étains de Tekkah was formed in 1910 and the Société des Étains de Bayas Tudjoh in 1925.

The first British company was the Gopeng Mining Co. floated by F. Douglas Osborne and E. R. Pike with Cornish capital in 1892, this company becoming, after amalgamation with the Ulu Gopeng Ltd. in 1912, Gopeng Consolidated Ltd. Judging only from the dates of incorporation, the earliest existing British companies are the Kinta Tin Mines Ltd., registered in 1900, and Tronoh Mines Ltd., registered in 1901. The pioneer firm of mining and consulting engineers in Malaya, Messrs Osborne and Chappel, dates from 1902. Other early comers were Rambutan Ltd. in 1905, Lahat Mines Ltd. and Pahang Consolidated Co. Ltd. in 1906, Kramat Pulai Ltd., Pengkalan Ltd., and Rahman Hydraulic Tin Ltd. in 1907, and Sungei Besi Ltd., and Austral Malay Tin Ltd. in 1908. The majority of the remaining companies were floated between 1911 and 1929, since when (no doubt on account of the Government prospecting policy since the introduction of tin restriction) there has been an almost complete cessation of flotation of new tin companies in Malaya. Two out of five such companies were consolidations of previous companies, the most important being Southern Kinta Consolidated, now the largest producing company in Malaya. The latest formed company is the Berjuntai Tin Dredging Ltd., incorporated in the Federated Malay States in 1937.

From the time of the formation of the first European company the tin-mining industry of Malaya shows continuous growth, following on the whole methods originally introduced and developed by the Chinese, as modified by the introduction of European machinery, such as power-operated pumps, and monitors for hydraulic sluicing.

It was not, however, until 1912 that the tin industry began to undergo a profound modification as the result of the commencement of dredging.

Owing to the difficulty of procuring the materials for building dredges during the war of 1914-1918, the further growth of dredging was impeded until after its conclusion. Since then this method of extracting tin has been increasingly employed, and the production of tin by dredging has enabled Malaya not only to maintain her previous rate of production where otherwise it would have fallen off, but has placed her in the position of being able to produce at a greater rate than ever before.

Geological Outline

Little was known of the geology of Malaya until a commencement was made by the appointment in 1903 of a geologist, namely, J. B. Scrivenor. He had a predecessor, however, Leonard Wray, Jnr., who was State Geologist and Curator of the Perak Museum.

The results of Wray's researches, especially with reference to the tin industry are given in a series of papers in the *Perak Museum Notes*, published in Taiping. Wray appears to have worked from about 1893 to 1903. Scrivenor worked alone until 1912, but subsequently other officers were appointed, the present Director of the Geological Survey being E. S. Willbourn, who succeeded Scrivenor. A geological map of Malaya has been prepared, the last edition being dated 1938.

Although our knowledge of the geology of Malaya is still but a sketch, nevertheless by combining the detailed knowledge of certain tracts with the results of preliminary survey over the remainder of Malaya, it has been possible for Scrivenor to produce a very readable account in his book *The Geology of Malaya.*

Scrivenor has also produced a second work, *The Geology of Malayan Ore Deposits*, which, although published earlier, should be read after the work on the geology of the country. By these two works Scrivenor has placed the geologists of the world and the mineral industries of Malaya very much in his debt and has brought the first stage in the investigation of the geology of Malaya and its mineral resources to a convenient starting point for further effort.

In a work entitled *Mining in Malaya* by H. G. Harris, Senior Warden of Mines, and E. S. Willbourn, published in 1936 by the Malayan Information Agency in London, there is an excellent summary of the geology of Malaya, from which the following passages are quoted :

" A geological map of British Malaya shows that the different rock-formations occur as elongated outcrops, roughly parallel with one another and with the length of the Peninsula. This arrangement has come about as a result of folding movements which crumpled rock-layers into a succession of parallel waves that were later eaten into by erosion. Granite masses occupying some of the anticlinal cores have been laid bare, flanked by the upturned edges of the various strata that formerly overlay them.

" The bedded rocks laid down before these folding movements are divided into two great rock-formations. The older comprises a calcareous series, of Carboniferous and Permo-carboniferous age, and consists of interstratified limestone and shale, which, in the mineralised districts have been metamorphosed to marble, slate, phyllite, or schist. Overlying is a sandy series, Triassic in age, of conglomerate, sandstone and shale, metamorphosed to quartzite-conglomerate, quartzite, hornstone, schist, phyllite, or slate.

" Granite and other igneous rocks were formed during the period of folding. Zones of low pressure, located under layers of bedded rocks thousands of feet thick, became occupied by intensely hot molten rock welling up from below, and some intrusions were of enormous size. On cooling, the molten material solidified as granite or other ' plutonic ' rock, which, it should be emphasised, was buried under a thick cover of metamorphosed bedded rocks.

Slight differences in the chemical composition of the original melt resulted in differences in the solid; hornblende-granite, syenite, diorite and gabbro are variants. The mineral wealth of Malaya has been derived from granite; little or none of it has come from the other igneous rocks. Finely crystalline or coarsely crystalline rock-types resulted from greater or less speed in cooling, or from variation in the quantity of fluxes present.

"The Main Range granite is an intrusion more than 300 miles long, and the width of its exposed outcrop is as much as 30 or 40 miles. The tin-fields of Kinta, Kuala Lumpur and Taiping are located near the west side of it; other smaller granite intrusions have been responsible for other Malayan tin-fields. These tremendously large reservoirs of hot viscous liquid, buried under their thick cloak of crystalline limestone, schist, and quartzite, took millions of years to cool. Earth movement continued during the process of consolidation, so that fissuring and foliation occurred even in the granite itself, particularly along the margin of the intrusion. Faults resulted, and a system of joint-cracks was formed everywhere by the shrinkage that accompanied cooling.

"Most of the tin, tungsten, gold, iron, lead and other metals, originally present in small proportions in the molten material that solidified as granite, became concentrated into a residual hot liquid, under pressure, far down under the consolidated rock. Some of the fault-fissures and joint-cracks penetrated to this metal-bearing liquid, which, thereupon, was forced up and became deposited in them, in the granite, or in the metamorphosed rocks near its periphery. Most of the resulting mineral-veins were small, but some were wide enough and long enough to be termed lodes.

"Long after this time, Malaya was elevated from the sea-floor to be part of a continent, and a period of severe erosion ensued, during which tens of thousands of feet of metamorphosed rocks were removed, and the cores of granite and other igneous rock were laid bare. The larger granite masses formed high mountain ranges, flanked by foothills of schist, quartzite, and crystalline limestone, with plains of limestone and shale alongside them. The erosion of the tin-veins resulted in the extensive alluvial tin-deposits of Malaya, and the characteristically pitted surface of the limestone plains formed an efficient trap for the retention of the heavy mineral-grains.

"Before the formation of the alluvial tin-deposits, in Tertiary times, coal-bearing strata were deposited in lakes, which occupied a comparatively small area of Malaya. After their deposition and consolidation they were partly removed by denudation."

The principal physiographical feature of the Peninsula is the Main Range, which runs slightly askew to the length of the Peninsula, dividing it into two unequal sections, so that the States of Kelantan, Trengganu, Pahang and Johore are situated entirely to the east of the Main Range, as is also the major portion of Negri Sembilan, and

about half of the Colony of Malacca. This Main Range is composed of the main granite intrusion of the Peninsula, and if we compare the geology with the physiography we may (although Scrivenor shows the range as terminating before reaching the sea), if we allow for the fact that the granite intrusion itself continues to the coast, regard the point at which the coast road between Muar and Malacca rises slightly to cross the granitic ground as marking the southern end of the Main Range.

To the west of the Main Range, reading from north to south, lie the States of Perlis, Kedah, Perak, Selangor, and the western portions of Negri Sembilan and the Colony of Malacca. For the major portion of its length the watershed of the main range coincides closely with State boundaries. In the north it separates Perak on the west from Kelantan on the east; further south Perak from Pahang, and then Selangor in turn from Pahang and the northern portion of Negri Sembilan.

Mineral Resources

Tin.—Since the major feature in the orography of Malaya may be regarded as the main axis of geological folding, it is not surprising that the mineral deposits of Malaya may be treated as roughly aligned in streaks parallel to the main axis. Taking first the tin deposits, we find that they occur mainly in a zone parallel to the main range and on its western side, stretching from Kedah in the north through the Taiping, Kinta Valley, and Bidor fields in the centre, and then through Ulu Selangor, Kuala Lumpur, and western Negri Sembilan, to near Port Dickson in Negri Sembilan and Kuala Linggi on the Malacca coast. These deposits are partly of primary tin-ore in veins and stockworks in the granite and in the older rock formations into which the granite is intrusive, and partly in secondary, eluvial and alluvial deposits derived therefrom by the processes of weathering and mechanical transport.

There are wide stretches of alluvium on the west coast of Malaya stretching all the way from Perlis in the north to Port Dickson in the south. Some of these tracts are already known to be stanniferous, and it is left for future research to decide the total extent of the tin-ore derived from the Main Range and its adjacent formations that has been buried in these alluvial tracts and constitutes a future reserve of tin-ore for recovery by dredging.

Moving eastwards we have numerous deposits of tin-ore in lode form as well as eluvial deposits in the Main Range itself, both on the western and the eastern sides. This is a tract in which enterprise is at present discouraged on account of the methods of lampanning or hydraulic treatment used in the past resulting in the silting up of streams on both sides of the Main Range. It is a tract, however, to which prospecting attention must eventually be directed.

On the eastern side of the Main Range deposits of tin-ore are of much less importance, but are known from Kelantan in the north through western Pahang, especially in the neighbourhoods of Bentong, as far south as eastern Negri Sembilan, and eastern Malacca. Further to the east of the Main Range there is an interrupted eastern belt of granitic intrusions in Kelantan, Trengganu, Pahang and Johore, which have given rise to another belt of tin-ore deposits relatively close to the eastern coast of Malaya.

From the foregoing it will be realised that there are two principal modes of occurrence of tin-ore in Malaya, namely as primary deposits *in situ*, in veins or lodes, stockworks or impregnations in granite or in the rocks into which granite is intruded; and, as secondary deposits consisting (*a*) partly of detrital or eluvial deposits overlying the stanniferous lodes and rocks, but chiefly (*b*) of alluvial deposits formed by the rivers of Malaya as a result of the decomposition and erosion of the rocks and lodes in which the primary tin-ore is contained, and of the eluvial deposits formed therefrom as an intermediate stage.

Owing to the wide extension of the tin-bearing granites of Malaya, tin-ore at one time or another has been found in every one of the States, except Brunei, and in every section of the Straits Settlements, except Penang, and, of course, the island settlements of Labuan and Christmas Island. At the present time tin-ore is being produced in each of the four Federated Malay States, in each of the five Unfederated States, and from Malacca in the Straits Settlements.

Strictly speaking, the crude tin-ore is the rock containing the crystals or granules of tinstone or cassiterite in the case of primary deposits, and the stanniferous eluvium and alluvium in the case of secondary deposits. No attempt is, of course, made to record the volumes or weights of such tin-ore in its unconcentrated condition, and it is only after the production of tin-ore concentrates by the various methods in vogue that measurement of quantity of production becomes feasible, so that when one speaks of production or exports or sales of tin-ore one is referring to tin-ore concentrates. Pure cassiterite or tinstone contains 78·6 per cent. of metallic tin and the object of washing and milling operations is to produce concentrates with a percentage of tin as near this figure as possible. In practice, of course, a lower figure is achieved, but it is now customary in statistical calculations to assume that the Malayan tin-ore concentrates contain 75·5 per cent. of metallic tin, though formerly a smaller figure, 72 per cent., was used. The ideal figures of production would be those recording the total production of tin-ore concentrates from each property, and thereafter from each State during a calendar year, especially as by comparing such true production figures with figures of exports it would be possible to ascertain the stocks remaining on the mines at the end of each

year. Such figures, however, do not appear to have been recorded in the past, although now that mines are allowed to accumulate stocks up to 25 per cent. of the allotted quota under the International Tin Control Scheme some procedure has presumably been introduced, requiring the record of actual production as distinct from exports.

By far the most important district is the Kinta Valley in Perak State, which appears to be the richest stanniferous tract in the world. Next in importance is Kuala Lumpur, and lastly come Batang Padang in Perak and Ulu Selangor in Selangor. The production of Batang Padang is probably much less than it may be in the future, for at present a large portion of the district is closed to mining on account of priority given to other interests. The Larut district in Perak is of much historical importance, because it is in this district that Chinese activity first became manifest many decades ago, leading to British intervention in Perak. The importance of the coast district in Pahang lies mainly in the presence therein of the Pahang Consolidated Company's mine at Sungei Lembing.

Ilmenite.—The crude concentrates obtained from dredging and other operations of the tin industry consist of tinstone, or cassiterite, mixed with other heavy minerals. The final stage of the concentrating operations is the washing of these concentrates in the tin sheds by skilled Chinese labour, using their time-honoured methods, with the resultant production of tin-ore concentrates fit for smelting and of refuse known as *amang*, containing but a trivial quantity of tin-ore. This refuse consists in many mines very largely of ilmenite, which of recent years has acquired a considerable market value, due principally to the development of the use of titanium oxide in the manufacture of white paints. This industry, based upon the black sands of the seashore of Travancore, has been developed of recent years, so that India is now the chief world's producer of ilmenite, the average annual output in the quinquennial period, 1929-1933, being 38,329 tons valued at £44,741, whilst the output for 1937 was 181,047 tons valued at £84,606.

The value of the Malayan ilmenite has only recently been recognised, and the first considerable exports appear to have taken place in 1935, when this mineral was grouped under exports of "other sorts of ore," the recorded value of the ilmenite varying from about 1 to 3 dollars per ton. If this is compared with the value allotted to the Indian production (£0·47 or $4 per ton in 1937), it will be seen that the Malayan ilmenite has been somewhat undervalued, and the presumption is that with better marketing facilities a higher price might be obtained.

According to the Annual Report of the Chief Inspector of Mines, that department is making a rough survey of amang heaps, a survey that has been in progress since March 1936. According to the Quarterly Bulletin for September 1938, stocks of amang

surveyed by that date amounted to 358,700 tons. It is not known how many years' accumulation this stock represents, and what is the annual addition to the stocks resulting from new operations.

Magnetic concentration is used in cleaning the amang and freeing the ilmenite from other minerals.

Tungsten.—Tungsten-ores (wolfram and scheelite) are derived from the same granitic source as tin. Unlike tinstone, wolfram being softer than quartz, does not last long under conditions of mechanical transport, but is ground away by the constant attrition of quartz, the principal constituent of river sands. Consequently, tungsten-ores are found in Malaya only in lode deposits (and eluvial deposits derived therefrom), and naturally in those tracts in which tin deposits have also been found. The chief occurrences of wolfram are at Sintok in Kedah and at various localities in Trengganu State, and of scheelite at Kramat Pulai in Perak. Wolfram has also been found in Perak, Selangor and Negri Sembilan, and scheelite in Selangor.

The two principal sources of tungsten of commercial value are the tungstate of iron and manganese, known as wolfram or wolframite, and the tungstate of calcium, known as scheelite, the latter mineral being much the less common. Malaya is perhaps fortunate in that the tungsten deposits of the country usually occur separately from the tin-ores so that regulation of the output of tin under the International Control Scheme has not also involved regulation of the output of tungsten. In Burma, where a much larger proportion of tin is derived from lodes, almost all such occurrences consist of mixed tin and wolfram ores, so that it is not practicable to control the production of tin from Burma without also controlling the production of wolfram. This is the principal reason why Burma has not adhered to the International Control Scheme for tin.

Gold.—The principal gold deposits of Malaya occur at Raub in the rocks of the Raub series regarded as Carboniferous in age. A long belt of such rocks extends from Kelantan State in the north through western Pahang and eastern Negri Sembilan to Malacca in the south. The only deposits of major value hitherto discovered in this belt are at Raub, but there is a succession of gold occurrences from north to south, and in view of the discovery of valuable gold deposits in the long-known Tomoh-Ulu Pergau auriferous area, on the Kelantan-Siamese frontier, it is not beyond the bounds of probability that future research may lead to the discovery of other workable gold deposits in this belt.

In 1938 gold was found for the first time in Malacca Territory associated with tin-ore at the Chin Chin Mine, both tin-ore and gold occurring in veins in decomposed shales.

Iron and Manganese.—Although iron-ore is known to occur in limestone in Perak State to the east of Ipoh, being used on dredges for ragging in jigs in many parts of the country, the valuable

supplies of iron-ore, manganese-ore, and bauxite, appear to be confined to a belt of country on the eastern side of the Main Range, all, except those of Batu Pahat in Johore, lying also on the eastern side of the Peninsula. Iron-ores are now being worked for export in Kelantan, Trengganu, and Johore, and manganese-ores in Kelantan and Trengganu. Valuable iron-ore deposits are reported also to have been discovered recently in Pahang to the west of Rompin.

The manganese-ores and iron-ores can, I find, be divided into two groups; those which appear to be interbedded with the associated rocks, and those which are obviously of superficial origin, having been formed at the surface by the replacement of pre-existing rocks by ferruginous solutions, and are conveniently designated by the term *lateritoid.* In all cases, whether interbedded, or the result of superficial replacement, the rocks with which they are interbedded, or which they have replaced, belong to formations shown on the geological map of Malaya as Triassic, though the replacement ores are, of course, of geologically recent origin. The manganese-ores of Malaya exemplify best both types of origin, those near Gual Periok in Kelantan being of lateritoid origin, whilst the manganese-ores of Machang Satahun in Trengganu are interbedded with sediments regarded as of Triassic age.

The iron-ores of Temangan in Kelantan and of Machang Satahun in Trengganu also appear to be interbedded hæmatites, although in both cases there has been superficial hydration with formation of a form of lateritoid.

The large iron-ore deposit of Bukit Besi in Trengganu State occurs in sections near a granite contact, but I see no reason for regarding the formation of iron-ore as in any way due to the intrusive granite. The iron-ore deposit at Bukit Langkap in northern Johore is associated with variegated lithomargic clay, and although the evidence is not clear, I see no reason for attributing to this deposit an origin different from those of Trengganu and Kelantan, where also the shaly and schistose country rocks of the ore-beds have been altered superficially to variegated clays as a result of tropical weathering.

The large iron-ore deposit at Sri Medan near Batu Pahat in Johore differs from the other iron-ore deposits in that it is associated with a volcanic breccia with only very subordinate shales. The tendency is for the iron-ore deposit to pass downwards into less ferruginous material, so that possibly it may be a large deposit formed by replacement of Triassic rocks, instead of representing a contemporaneous deposit. There is no evidence to show whether the source of such replacing solutions is from above or below; I saw no evidence favouring the second hypothesis. In any case, all the iron-ore deposits of eastern Malaya appear to be associated with Triassic rocks, and in view of the wide extent of country occupied by these rocks in eastern Malaya we must anticipate that the dense

jungles of this part of the Peninsula contain still undisclosed deposits of iron-ore.

An interesting geological observation made at the Bukit Besi iron mine in Trengganu was of varved sediments. These varved sediments, with alternating pale and dark bands, are probably to be interpreted as representing seasonal variations at the time of deposition. Similar varved sediments were also discovered in a road cutting near the Sungei Lembing tin mine of the Pahang Consolidated Company in Pahang. The country rocks of the iron-ores of Bukit Besi and of the tin-ore of Sungei Lembing are regarded by the Geological Survey as of Triassic age. This discovery of varved sediments in both localities may be regarded as corroborative evidence of the correctness of this correlation, as well as providing evidence if the conditions under which the sediments of the two localities were laid down.

Bauxite.—The bauxites of Malaya are of recent discovery and are found in southern Johore and near Batu Pahat in western Johore. They are a form of laterite and consequently of superficial origin and small extent in depth. Whilst each deposit is, therefore, likely to be only of moderate size, there seems to be no reason why future exploitation should not lead to the discovery of further deposits, with the possibility that the total bauxite reserves of Johore may be considerable or even large. Bauxite is the aluminous form of laterite and is often covered by ferruginous laterite at the surface, so that deposits may remain for a long time undetected.

The deposit at Bukit Pasir near Batu Pahat is of especial interest because it provides direct evidence of changes of level of this portion of the Peninsula. The deposit forms a low mound, the edges of which dip below sand and clay containing coral and marine shells, the coral in places growing actually on the laterite. The highest point of this deposit is only 18 ft. above sea-level. The conditions of formation of laterite require that this deposit must have been formed at a higher level, whilst the presence of marine shells and coral prove that since the formation of the deposit, it has been lower than it is now and has since been re-elevated.

Coal and Petroleum.—Malaya is, unfortunately, poor in sources of coal. One valuable coalfield has, however, been discovered, namely, at Batu Arang in Selangor State, the associated rocks (sandstone and shales) being of Tertiary age. Four other deposits have been found, namely, in Perlis State on the Siamese frontier, at Enggor in Perak, and at two localities in Johore. When it is realised that these deposits are younger than the granites of the Main Range, and have presumably been formed subsequent to the elevation thereof, it is not surprising to learn that they do not occur in belts parallel to the Main Range ; in fact, the Perak and Selangor occurrences are on the west side of the Main Range and the Johore occurrences on the east side.

The conditions of deposition that have led to the formation of

workable coal at Batu Arang and at Enggor, and of the traces of coal in the other occurrences, led also to the formation in places of oil shales. Unfortunately the percentage of oil present is not sufficiently high to warrant exploitation.

Coal has also been worked in Labuan, one of the Straits Settlements; and is still being worked in Brunei State, one of the Unfederated States of Malaya. Petroleum and natural gas have also been regularly won in the Seria oilfield in Brunei since 1931.

Building Stone.—Malaya contains vast reserves of good granite and limestone, as well as shales, some of which must be suitable for the manufacture of cement. A considerable proportion of the production of limestone is for fluxing in the iron and steel industry.

Phosphate of Lime.—Deposits of rock phosphate, or phosphate of lime, occur at Christmas Island, which is one of the Straits Settlements and lies in the Indian Ocean about 190 miles south of the western extremity of Java. This phosphate results from interaction between solutions derived from guano deposits and the underlying limestone. These deposits have been worked since 1899 and the exports have varied from 4,855 tons in the first year of working to 162,568 tons in 1937. The growth, however, has not been continuous and the exports reached as high a figure as 156,781 tons as long ago as 1912, falling to a figure of 25,908 tons in 1915 during the war of 1914-18.

Whilst Japan has been the principal importer of Christmas Island phosphate, other large importers at intervals have been Australia, Germany, Hungary, Denmark and Sweden.

China-Clay. There is a small production of china-clay, for use in the rubber industry, obtained from a quarry in kaolinised granite near Tapah in Perak State and most of this is utilised within the State.

Other Minerals.—Besides the minerals mentioned above, there are occurrences in Malaya of several other minerals of possible economic value, such as fluorspar, lead-ore, copper-ore, monazite and zircon. None of these minerals is at present being exploited, but there have been occasional records of the production of a small quantity of lead-ore (33 tons of galena in 1935 and 3½ tons in 1936). This was from the State of Pahang.

Fluorspar, which is of value as a flux in certain metallurgical processes, occurs in association with the scheelite of Kramat Pulai, and according to the latest Annual Report of the Mines Department there is now a stock at that mine of 50,000 tons of this mineral. A trial shipment of 20 tons has been made to England, but no market has been acquired, it is stated, because the fluorine content is too low.

The production of 32·89 tons of cement copper in the year 1936 has been recorded. This represents copper recovered from solution at the Sungei Lembing tin mine of the Pahang Consolidated Company by deposition with iron.

Monazite occurs with the tin-ore in various parts of Malaya and in the course of magnetic treatment monazite has in some cases been separated from the cassiterite, but no regular market has been found, the percentage of thoria being, it is stated, on the low side. Monazite occurs in the sands of the Langkawi Islands, as does zircon. Zircon also occurs mixed with ilmenite in amang.

Water Power.—Malaya possesses no snowfields or glaciers and consequently possesses no *houille blanc*, using this phrase in its true sense. But Malaya does possess a heavy rainfall, well distributed throughout the year, so that if sufficiently large catchment areas could be found with gentle gradients near suitable sites for dams, there would appear to be a *prima facie* possibility of development of large hydro-electric schemes. No comprehensive survey has, I understand, been made of this problem; but owing to the steepness of the slopes in the Main Range, for instance, it seems evident that there can be no possibilities of cheap storage of large volumes of water, and consequently no possibilities of cheap generation of electric energy. In cases where the cost of electric energy is not of vital importance it is obvious, however, that Malaya must possess certain hydro-electric possibilities, and several small schemes have been developed, partly by mining companies for their own power purposes and partly by Government for general purposes.

Mineral Production

As an indication of the extent to which the mineral resources of Malaya have become the subject of exploitation, it is desirable to conclude this account with some statistical data. This subject is treated more fully in my *Report upon the Mining Industry of Malaya* published at Kuala Lumpur, 1939, where 40 years' statistics are given. It is of interest to summarise here the data for the quinquennial period 1934 to 1938, and to compare the results with the averages for the previous quinquennium. This is done in the accompanying table, the minerals being arranged in descending order of value in 1938. Some of the data are incomplete, especially the values of the output of the Unfederated Malay States, and in such cases estimates have been made. Where possible the figures refer to production, but in many cases figures of exports must be taken as representing production. The figures of value are in italics.

The figures in this table speak for themselves and do not need separate discussion. To one point, however, attention may be drawn, namely the steady increase in the value of the production of minerals other than tin, quite irrespective of the wide fluctuations in the value of the tin production. This increase has been from £1·85 millions in 1934 to £3·0 millions in 1938.

MINERAL PRODUCTION OF MALAYA, 1934 TO 1938

		1934.	1935.	1936.	1937.	1938.	Mean 1934-38.	Mean 1929-33.
Tin	Tons	33,919	42,319	66,703	77,192	43,374	52,701	47,624
	£	7,584,124	9,193,978	13,134,051	17,901,544	7,912,951	11,145,329	7,601,124
Iron ore	Tons	1,135,648	1,411,635	1,654,996	1,560,828	1,616,099	1,475,841	752,322
	£	582,519	696,042	752,837	851,702	871,798	750,979	510,581
Coal	Tons	321,888	392,178	520,799	628,951	477,962	468,356	426,252
	£	180,650	223,326	302,700	387,443	376,526	294,129	286,795
Gold	Oz.	32,822	30,644	38,610	34,653	40,794	35,505	29,364
	£	218,548	215,026	248,513	222,789	364,444	253,864	139,254
Phosphates	Tons	128,831	147,929	161,440	162,568	159,859	152,126	96,902
	£	255,515	293,393	320,189	322,427	300,000*	298,305	210,215
Tungsten ore	Tons	1,603	1,634	1,639	1,099	891	1,373	716
	£	194,294	215,279	212,392	193,354	130,260*	189,116	42,164
Building stone	Tons	545,263	717,728	829,785	1,062,851	1,020,947	835,335	399,527
	£	63,614	83,735	96,808	124,011	115,610	96,756	46,611
Bauxite	Tons	—	—	36	12,627	55,751	13,683	—
	£	—	—	21	7,366	32,521	7,982	—
Manganese ore	Tons	18,649	28,045	36,777	32,793	31,970	29,649	16,948
	£	21,325	30,561	39,511	34,085	31,310*	31,358	15,811
Ilmenite (amang)	Tons	—	2,431	10,331	6,252	6,462	5,095	—
	£	—	860	3,127	1,566	1,885*	1,488	—
China clay	Tons	307	96	121	293	1,153	394	384
	£	812	277	353	838	1,078*	672	915
Total value	£	9,433,130	11,349,273	15,520,118	20,621,598	10,909,556	13,566,735	9,011,434

* *Estimated.*

THE POLISH OIL INDUSTRY

The acquisition of Poland by Germany and the U.S.S.R. has made the subject of the Polish oilfields one of great topical interest, and D. E. Morgenstern, who has native experience of the industry in the country, has recently written an invaluable article on the Partition of Poland's Oil Industry (*World Petroleum* 1939, **10,** No. 11, pp. 32-39).

The area of Poland was 149,958 sq. miles, and the partition line between the German and Russian occupied territory is drawn from north to south along the rivers Pissa, Bug and San. The German area amounts almost to 60 per cent. of the country with a population of 21 million people, and includes the cities of Warsaw, Lodz, Poznan, Krakow and Katowice. The U.S.S.R. has acquired the remaining territory with 13 million inhabitants and the city of Lwow.

Of the 20,118 km. of standard-gauge railways close on 62 per cent. falls to Germany, while only 8,160 km. are in Russian hands. The 60,700 km. of roads are generally in bad condition ; 38,000 km. of them go to Germany and 22,000 km. to Russia.

Oil Production

The total oil production in Poland in 1938 was 3,801,000 bls. or 0·19 per cent. of the world's total output. Some 35 per cent. of this came from territory west of the San River, now German.

The 1938 figures show a surplus of production over consumption of 10 per cent. Germany has incorporated that part of Poland which includes 80 per cent. of Polish industry with about 80 per cent. of the Polish oil consumption, but since this area produces only 35 per cent. of the Polish petroleum output, or 920,000 bls. per year, it will require an import of 2,100,000 bls. annually to maintain its normal economy.

Russia received the important wells at Boryslaw, Rypne, Bitkow, Schodnica and Urycz. With 65 per cent. of the Polish output, the gain is about 2·2 million barrels annually, a figure equivalent to only about 4 days of total Russian oil production. The cost of production of oil in Russia is much lower than in Poland, and because of transportation difficulties it is to be expected that the surplus oil will be exported to the German territories.

Refining

The refining industry of Poland was situated in the producing area. Of the 37 refineries, 13 of the biggest have a capacity of 7,524,000 bls. out of a total capacity of 8,700,000 bls.

The four largest refineries are situated at Czechowice, Trzebinia, Dziedice and Lwow, and the next largest mainly in German territory, at Glinik-Marjampolski, Libusza (now out of operation), Jaslo, Jedlicze, Krosno and Usztrzyki. The remaining four large

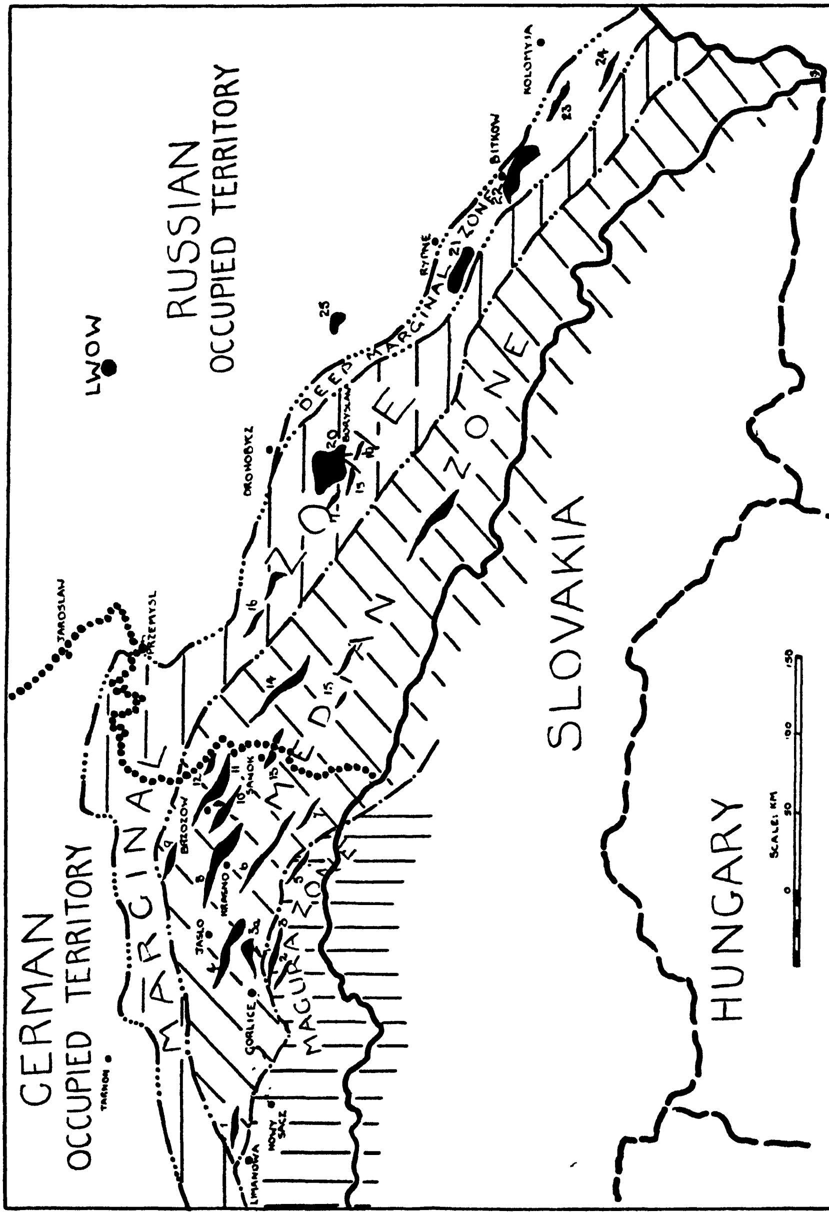

FIG. 1. SKETCH-MAP OF POLISH OIL FIELDS.

refineries are at Drohobycz, and together with the Lwow refineries will form an important refining centre for Russia.

The Polish refineries are usually of the older type, and some are examples of the first type ever built.

There are only 3 cracking plants, in Drohobycz (Galicja Oil Co.), in Glinik-Marjampolski (Malopolska Oil Co.), and in Czechowice (Vacuum Oil Co.). The largest concern in the industry is the Malopolska Oil Co. owning the six largest refineries and treating almost 45 per cent. of the total crude oil output of the State. Four of these refineries were working at 80 per cent. capacity.

Transportation facilities for crude oil going to Germany are good, as that part of the oil industry taken by the Reich is mostly situated close to railway stations, and the Czechowice and Dziedzice refineries are practically on the Polish-German frontier.

Oil for Russia, however, will have to be transferred at the old frontier owing to change in railway gauge.

Drilling and Production Practice

Most of the wells in Poland have been drilled by the Canadian and cable-tool methods, as the hard, caving and irregular formations do not warrant expensive rotary outfits. Costs are about $10·73 per ft. on the average. Among the 3,740 oil-producing wells, there are only 20 flowing holes, 903 bailing and swabbing wells, the remaining 2,690 being pumped. Air-lift and water-flooding methods are unknown except in a few isolated cases. In only five fields was air-flooding applied, and despite increases in production of from 50 to 200 per cent., in four cases it was stopped after 2 to 4 years of application because of mechanical and economic considerations.

Bailing is often more practical than pumping because of the large diameter of Polish wells and the abrasive action of sand-laden oil on the pumps.

Swabbing is used mostly in the eastern fields of Boryslaw, Rypne and Bitkow where the pressure is insufficient for flowing production and the wells are too big to be pumped. The process may produce as much as 2,000 bls. per day.

Oilfields

Oil is produced in Poland from four separate zones running parallel to the Carpathian arc, from Gorlice to Bitkow, a distance of about 220 miles. These are the Magura, Median, Marginal and Deep Marginal Zones.

The most important oilfield is the Boryslaw-Tustanowice-Mraznica in the Marginal Zone, and the largest gas field is the Daszawa, 21 miles east of Boryslaw in the Deep Marginal Zone.

1. *Magura Zone.*—This, the innermost zone, is situated immediately south of Gorlice, and is of very limited extent. The strata consist of a succession of grey, green and red shales with

thick sandstones of Oligocene and Eocene age, and oil has been produced only in limited quantity from four districts, namely Mecina Wielka, Sekowa-Ropica Ruska, Szymbark and Harklowa-Pagorzyna-Wojtowa.

The *Mecina Wielka* field (No. 3[1]) lies 8 miles east of Gorlice and has been active since before 1875. Oil occurs at three horizons between depths of 300 and 1,200 ft. in Cretaceous sediments, and at July 1, 1939, there were 27 active wells yielding a total of 620 bls. a month. The deepest hole to date has gone down to 2,600 ft. but was abandoned. The nearest railway station is at Gorlice and the principal leaseholders are Slaskie Tow. Naftowe Oil Co. and Morgenstern and Company Oil Co.

The *Sekowa-Ropica Ruska* oilfield (No. 3) lies 3 miles south-east of Gorlice. There are several oil horizons in the Upper Cretaceous between depths of 250 and 1,000 ft., which were under intense development by 1878, and up to December 1938 had yielded 715,000 bls. of oil. Wells are spaced over an area of 6,500 acres, and are variously owned by Morgenstern and Company Oil Co., Gorlicka Nafta Oil Co., Wladyslaw Dlugosz Oil Co. and a few independent small producers.

The *Szymbark* field (No. 2) is situated 3 miles south of Gorlice and since 1870 has produced about 210,000 bls., though the present output per well has fallen to 0·4 bls. daily. At present there are 12 wells in the field which covers 400 acres, and the active concerns are Fr. Pizicha Oil Co., Gorlicka Nafta Oil Co., Morgenstern and Company Oil Co., St. Haluch Oil Co. and the Bystrzya Oil Co.

The *Harklowa-Pagorzyna-Wojtowa* district (No. 4) covers some 6,700 acres about 10 miles north-east of Gorlice and up to the end of 1938 had yielded 1,850,000 bls. of oil. Present output is about 5,500 bls. per month from 150 wells, and this figure could be improved upon by applying repressuring measures to the oil reservoirs. Active oil companies are the Harklowa Oil Co., Ropita Oil Co. and Malopolska Oil Co.

2. *Median Zone.*—This zone lies north of the Magura Zone and is of much greater lateral extent, though the oilfields are mainly between Gorlice and Sanok. Geologically the area consists broadly of a series of anticlines of Oligocene and Eocene strata, together with thrust masses of Cretaceous sediments. Oil-bearing formations occur in all three series of rocks.

The *Kleczany* field (No. 1) is the oldest in Poland having produced oil as early as 1856, which was distilled at one of the world's oldest refineries built at Kleczany in 1864. Some 11 wells over an area of 2,500 acres still yield a barrel a day. Active companies are the Kleczany Oil Co. and Nafta Boryslawska Oil Co.

The *Kobylanka-Libusza-Lipinki-Kryg* field (No. 3a), 4 miles east of Gorlice, is one of the most promising in Poland, and has pro-

[1] *See* accompanying sketch map on p. 84.

duced more than 4½ million barrels of oil over a proved area of 72,000 acres. At present there are 650 wells yielding 28,000 bls. per month. A deep well recently put down by Morgenstern & Co. had promising oil shows in the Cretaceous which may indicate a new, deeper field.

At *Biecz-Zalawie* (No. 4), 7 miles north-east of Gorlice, oil is produced from three horizons in an area of 3,500 acres, between depths of 600 and 2,100 ft. There are 48 active wells yielding 1,900 bls. a month, and 300,000 bls. of oil have been obtained since development started in 1897.

The *Bobrka-Wietrzno-Rowne-Rogi* field (No. 6) at one time was the premier in the country. It is situated about 30 miles due east of Gorlice, covers an area of 21,000 acres, and 95 wells yield oil from three horizons in the Eocene and one in the Cretaceous between 1,000 and 3,700 ft. Up to the end of 1938, 5½ million bls. of oil had been taken from the field, and production has declined to 5,500 bls. per month. Up to the beginning of the war no new drilling had been started.

The *Magdalena* or *Gorlice* field, Poland's newest producer, was discovered in 1931 as a result of oil seepages from Oligocene and Eocene strata. In addition to oil the Eocene Ciezkowice Sandstone yields about 600,000 cu. ft. of gas daily.

The field proved so far covers 28,000 acres and at the beginning of 1939 there were 40 wells producing 2,500 bls. per month. The only active oil company is the Minerwa Oil Co.

The *Mecinka-Sadkowa-Dobrucowa* field (No. 8) between Jaslo and Krosno has a high gas yield, there being 16 gas and 16 oil and gas wells which tap two main horizons in the Eocene and the Cretaceous, at depths of 2,300 to 3,000 ft. and 3,200 to 3,900 ft.

Present production is 4,200 bls. of oil and 56 million cu. ft. of gas per month from an area of 56,000 acres.

The *Potok-Toroszowka* oil and gas field (No. 8), 4 miles east of Krosno, covers 20,000 acres, and 107 oil wells yield 12,000 bls. per month together with 11 million cu. ft. of gas.

At *Krosno* (No. 8) oil is obtained from three fold-structures at four different horizons in Eocene strata between depths of 650 and 2,300 ft. The wells now active number 46 and yield 2,400 bls. of oil per month. Cleaning and deepening activities which might have augmented the output were in progress before the war commenced. The producing area is 7,000 acres.

The *Weglowka* field (No. 9) covers some 6,000 acres immediately north of Krosno, and from oil horizons between 400 and 1,500 ft. deep in Cretaceous sediments, 2,000 bls. per month are got through 85 wells.

The *Iwornicz-Klimkowka* field is 9 miles east of Krosno and consists of two anticlines, in the northerly one of which oil is found at three horizons in the Eocene Ciezkowice Sandstone, while the southerly one has three horizons in Oligocene measures. Production is much larger from the southern fold, and at present 60 wells in

the whole field yield 1,900 bls. per month. The proved area is 20,000 acres.

About 5 miles south of Brzozow is the *Zmiennica-Turzepole-Strachocina* field (No. 10) which covers an area of 2,000 acres and yields 2,000 bls. per month from 41 wells. The oil-bearing horizons are at depths between 200 and 2,500 ft. in Ciezkowice Sandstone and from 1880 to 1938 over 700,000 bls. of oil were obtained.

In 1896 the *Brzozow-Starawies* field (No. 11) was discovered about 11 miles north of Sanok and proved to extend over 16,000 acres. The oil comes from Upper Cretaceous formations at three horizons between 1,650 and 3,300 ft. There are now 62 wells with a total production of 7,300 bls. per month.

Near Sanok itself is the *Sanok-Zagorz* field (No. 13) which is now practically exhausted the output being only 150 bls. a month.

The *Stankowa-Ropicuka-Leszczowate* field (No. 14), 13 miles east of Sanok, contains a large number of oil horizons which have been extensively tested. At present over an area of 3,500 acres there are 385 wells supplying 13,500 bls. of oil monthly.

3. *Marginal and Deep Marginal Zones.*—Adjoining the Median Zone on its northern side is the Marginal Zone which at its eastern end exhibits additional structures away from the Carpathian axis known as the Deep Marginal Zone.

The sediments composing the zone structures are mainly Cretaceous limestones with sandstones, marls, dark shales and clays, and Eocene green and red shales with intercalated thin, hard, green sandstones. The Marginal Zone includes the following more important oilfields, Strzelbice, Urycz, Schodnica, Boryslaw-Tustanowice-Mraznica. The Deep Marginal Zone includes the following fields, Rypne, Duba, Majdan, Bitkow, Pasieczna, Sloboda-Rangurska-Kosmacz.

The *Strzelbice* field (No. 16) is a small one lying 5 miles west of Stary Sambor. Oil is obtained from relatively shallow wells at the rate of 1,360 bls. a month. Since 1881 the area has furnished 650,000 bls.

Some 5 miles south of Boryslaw is situated the *Schodnica* field on an overthrust in the marginal Carpathians. This locality was for a time the most important oil-producer in Poland and up to 1938 had yielded 17 million bls. in a period of 56 years. The depth from which the crudes arise varies between 1,000 and 1,600 ft. and output is now at the rate of 25,000 bls. monthly.

Active companies are the Gazy Ziemne Oil Co., Galicja Oil Co., Schodnicka Ska. Naft Oil Co., Brzozowski and Winiarz Oil Co., and S. R. Backenroth Oil Co.

Immediately south-east of Schodnica is the *Urycz* field yielding oil from depths of 800 to 1,050 ft. in an anticline of Eocene sediments. The field covers an area of 25,000 acres and has an output of 4,950 bls. per month.

There are indications that the deeper Cretaceous formations to the south-east may be potential producers.

The *Boryslaw-Tustanowice-Mraznica* field (No. 20) is by far the most important in Poland. There are seven producing formations of Eocene age which up till now have furnished 70 per cent. of the total Polish oil or 177 million bls. The highest yield was obtained in 1909 at 13·8 million bls., and at present 654 wells are giving 154,000 bls. a month and 130 wells 17½ million cu. ft. of gas.

The proved oil-producing area covers 150,000 acres, but there are possible extensions of the field in adjacent localities. Active oil companies include the Malopolska Oil Co., Nafta Oil Co., Galicja Oil Co., Premier Oil Co., Fanto Oil Co., Limanowa Oil Co., and Schodnicka Nafta Oil Co.

An area of 62,000 acres about 21 miles south-east of Stanislawow constitutes the *Rypne-Duba* field (No. 21) yielding oil from 137 wells in Eocene and Menelitic (Oligocene) sediments. The field is an oil one and now gives an output of 8,500 bls. monthly.

The *Majdan-Rosulna* locality (No. 21), 5 miles south-east of Rypne, has the same tectonic formations as that field. Oil is obtained at depths from 130 to 1,000 ft. over 17,000 acres, and the present rate from 110 wells is 1,650 bls. a month.

At *Bitkow* (No. 22), 22 miles south-west of Stanislawow, oil is obtained from 118 wells at the rate of 13,400 bls. monthly. The proved area is about 70,000 acres and from 1870 to 1938, 6½ million bls. of oil had been obtained.

The *Pasieczna* (No. 22) adjoins the Bitkow field and yields oil from 41 wells at the rate of 2,380 bls. per month. The producing horizons are at depths of 800 to 1,200 ft. over an area of 9,000 acres, and from 1882 to 1938 about 820,000 bls. had been obtained.

The *Sloboda-Rungurska* field (No. 23) is one of the oldest in Poland and lies 11 miles south-west of Kolomyja. The oil wells, 52 in number, are situated on the southern flank of a large anticline, over an area of 45,000 acres, and yield 960 bls. per month.

The *Daszawa* field (No. 25), 21 miles east of Boryslaw, was discovered in 1912, and is the most important gas field in Poland. Structurally, the locality is a dome in Miocene marls and sandstones, with two gas horizons. The main supply of gas comes from a depth of about 2,400 ft. at an initial pressure of 850 lbs. per sq. in. The gas is dry with an average composition of 94·5 per cent. methane; 2·2 per cent. oxygen; 3·2 per cent. nitrogen; and 0·1 per cent. carbon dioxide. The yield between 1920 and 1928 amounted to 52,000 million cu. ft. and present production is about 12 million cu. ft. daily. This field has a promising future as the same formation extends over a radius of 28 miles.

A small field exists at *Kosmacz* (No. 24), 14 miles south of Kolomyja, and supplies about 310 bls. of oil monthly from 10 wells sunk to depths of between 230 and 720 ft. in Cretaceous strata. The area, consisting of 2,500 acres, is now practically abandoned.

PROGRESS IN COLONIAL MINERAL INDUSTRY

Comprising periodic statements on mining and geological activities received from Government Technical Departments overseas.

CYPRUS

The following report has been received from the Inspector of Mines regarding mineral production during the period October 1, 1939, to December 31, 1939.

Cyprus is the principal Empire producer of cupreous pyrites and the prosperity of the mining industry in the Colony is, to a great extent, dependent on the producers of this mineral finding ready markets overseas. Prior to the outbreak of war the production and exportation of cupreous pyrites had reached record levels and there was evidence that the expansion of the mining industry, which had been so marked during the past four years, would continue. The commencement of hostilities, however, led to the loss of markets with the resultant serious decline in the exports of this raw material.

The production of cupreous pyrites fell from 501,683 tons in the first half of 1939 to 341,613 tons in the second half-year, and exports fell from 275,645 tons to 121,909 tons. Exports of cupreous concentrates fell from 86,521 tons to 33,471 tons in the same period.

During the last quarter of 1939 there was a considerable decrease in the tonnage of asbestos mined and exported as compared with the previous quarter. The decrease was due to the working season having closed during the quarter.

There was a marked increase in the tonnage of terra umbra shipped. This material is chiefly exported to the United States.

No chrome ore was exported during the period under review.

MINERAL PRODUCTION AND EXPORTS, OCTOBER-DECEMBER 1939

	Production. *Tons.*	Exports. *Tons.*
Cupreous pyrites (dry weight)		
Skouriotissa Mine	10,255	4,451
Mavrovouni Mine	124,402	29,248
Lymni Mine	226	—
Kalavasso Mine	—	—
Akoliou Mine	2,950	—
Cupreous concentrates (dry weight)		
Mavrovouni Mine	—	14,777
Chrome ore		
Mined	1,750	—
Treated	578	—
		Troy oz. fine.
Gold (contained in ores, concentrates and precipitates)	—	3,151*
Silver (contained in ores, concentrates and precipitates)	—	18,871*
Asbestos (Tunnel Asbestos Cement Co., Ltd.)		*Tons.*
Rock mined	118,720	—
Rock treated	32,608	—
Asbestos fibre	1,203	1,320
Other minerals exported		
Gypsum, calcined	—	490
Gypsum, raw	—	552
Terra umbra	—	3,294
Terra verte	—	9

* *Based on provisional returns*

GOLD COAST

The following report on the activities of the Geological Survey Department for the half-year ended December 31, 1939, has been forwarded by the Director.

During the period under review the work of the Survey was severely restricted owing to the calling up for military service of three geologists, one engineer and two foremen, and to the absence on leave of two officers for part of the time.

A detailed geological survey was made of the area, including Accra, most severely affected by the earthquake of June 22. A preliminary report on the earthquake was published in August and a full report is now in course of preparation.

The study of the surface and underground geology of mining fields was continued and reports on the geology of five gold mines in the Tarkwa goldfield were completed.

The work of the water-supply section in providing village water supplies was continued on a restricted scale in the Dagomba and Mamprussi Districts of the Northern Territories.

On behalf of the Geological Survey a series of extraction tests on samples of bauxite from the Ejuanema, Sefwi Bekwai and Yenahin deposits was carried out by the Imperial Institute to ascertain whether calcination of the bauxite affected the solubility of the alumina.

The samples were ground to pass a No. 14 British Standard sieve and then calcined at a temperature of 400° C. before being digested for 6 hours with caustic soda in an autoclave under a pressure of 80 lb. per sq. in.

The results showed that calcination had practically no effect on the solubility of the alumina in two of the samples and that only a slight reduction in solubility occurred in the third sample.

NEWFOUNDLAND

The following information regarding the mineral production of Newfoundland, for the last quarter of 1939, has been submitted by the Associate Government Geologist.

MINERAL PRODUCTION, OCTOBER-DECEMBER 1939

	Tons.
Buchans	
Crude ore	120,869
Concentrates:	
Copper	17,172
Lead	8,505
Zinc	28,068
Gravity	77
Bell Island	
Iron ore	410,089
St. Lawrence	
Fluorspar	3,325
Aguathuna	
Limestone	52,595

NIGERIA

The following information for the last quarter of 1939 has been received from the Chief Inspector of Mines.

Tin.—The quota for free export was fixed at the commencement of the quarter at 60 per cent. of standard tonnage, and was successively increased to 70 per cent. and 100 per cent.

At Government's request, producers made special shipments from their stocks, and from the last month of the third quarter up to December 31, 1939, approximately 3,490 tons of metal (estimated at 72·5 per cent. Sn) were exported from Nigeria.

During the quarter the output amounted to approximately 3,128 tons of metal, and at the close of the year the stocks on hand amounted to 1,206 tons.

MINERAL PRODUCTION AND EXPORTS, OCTOBER-DECEMBER 1939

	Production.	Exports.
	Tons.	*Tons.*
Tin ore	4,314	4,363*
Columbite	126·154	—
Wolfram	43·388	42·466
	Troy oz.	
Gold	5,873·28	—

* *In addition there was a special shipment from stocks of* 4,431 *tons.*

NORTHERN RHODESIA

The following statements relating to mining activities during the last quarter of 1939 are taken from a report furnished by the Chief Inspector of Mines.

Prospecting.—Only eleven prospecting licences were issued during the quarter and there was little prospecting in progress outside the concession areas. In the Rhodesia Minerals Concession Ltd. area prospecting and mapping continued until November, when work was suspended, but no discoveries of interest were made. In the Rhokana Corporation Ltd. concession area prospecting and geological mapping continued throughout the quarter and at Kirila Bomwe three diamond drill holes encountered copper ore of commercial grade. Choma Tin Ltd. carried out prospecting in the area to the south of Choma, located some patches of detrital cassiterite and started sinking a shaft on a pegmatite vein. The two locations registered during the quarter were both for iron.

Mining.—As a direct result of the war there was progressive increase in the production of blister copper practically the whole of which, as well as the electrolytic copper produced, was taken over by the Imperial Government. The total value of the minerals produced during the quarter was £3,474,277, compared with £2,813,526 during the preceding quarter. The increase was more than accounted for by the increase in tonnage and price of blister copper. There were also increases in the value of electrolytic copper and zinc, but there was an appreciable falling off in the production of cobalt alloy.

The following table shows the output of minerals for the quarter under review and for the year.

MINERAL PRODUCTION, 1939

	Oct.—Dec.	Jan.—Dec.
Gold . . .	1,158 *oz.**	4,643 *oz.**
Silver . . .	1,798 ,, †	61,183 ,, †
Cobalt alloy . .	18,553 *cwt.*	76,601 *cwt.*
Copper, blister .	56,744 *tons.*	182,014 *tons*
,, electrolytic .	7,239 ,,	29,654 ,,
Iron Ore . .	136 ,,	136 ,,
Lead . . .	160 ,,	160 ,,
Manganese ore .	13 ,,	2,970 ,,
Selenium . .	—	1,277 *lb.*
Vanadium pentoxide	165·56 *tons*	674·13 *tons*
Zinc . . .	3,405 *tons*	12,695 *tons*
Limestone . .	12,999 ,,	46,133 ,,
Mica . . .	300 *lb.*	5,423 *lb.*
Silica rock . .	—	3,430 *tons*

* *Estimated.* † *Subject to adjustment.*

Gold.—After having been closed down for nearly nine months the Chakwenga Mine was reopened towards the end of September with a view to commencing production on a small scale. By the end of the quarter a Tremain mill and accessory equipment had been erected. The Dunrobin Mine was dewatered to below the 4th level and the driving east and west of that level was resumed. During the quarter, 6,257 tons of ore were treated at this mine and bullion containing approximately 1,167 oz. of fine gold recovered.

Copper.—The quantities of ore treated, and blister and electrolytic copper recovered by the Mufulira, Nchanga, Nkana and Roan Antelope Mines during the quarter under review are shown in the subjoined table.

Mine.	Ore treated.		Copper Recovered.				Copper Content.
			Blister.		Electrolytic.		
	Tons.	*Per cent. Cu.*	*Tons.*	*Per cent. Cu.*	*Tons.*	*Per cent. Cu.*	*Tons.*
Mufulira . .	480,955	4·66	18,709	99·43	—	—	18,602
Nchanga . .	26,205	4·05	964	99·71	—	—	962
Nkana . .	701,339	3·53	17,078	99·71	7,239	99·95	24,265
Roan Antelope .	744,643	3·06	19,993	99·47	—	—	19,887
Total . .	1,953,142	3·64	56,744	99·53	7,239	99·95	63,716

At the Mufulira Mine the deepening of No. 5 shaft was completed, as far as the present programme is concerned, the total depth being 1,545 ft. The new ventilation shaft, known as No. 8 shaft, was excavated to a depth of 16 ft., the concrete collar and headframe foundations poured and a hoist and boiler-house erected. The electric hat lamps and batteries, with which all underground employees are to be supplied, arrived on the property and their issue commenced.

At the Nchanga Mine the sinking of the "A" and "B" inclined shafts was continued, the inclined depths being 3,246 ft. and 2,491 ft. respectively at the end of the quarter. In the "A" shaft the intersection of water-bearing fissures necessitated cementation ahead of sinking. The draining of the hanging-wall country by diamond drilling, and consequent lowering of the water table continued, as did also the development for stoping on and above the 360 ft. and 480 ft. levels, and stoping above the former level. At the power station the fourth direct-fired International Combustion boiler was completed, with auxiliaries and an additional cooling tower erected.

At the Nkana Mine the concrete lining of No. 5 shaft, an up-cast ventilation shaft, and the replacement of the wooden sets by steel ones was commenced in October. In November development on the 1,680 ft., 1,910 ft. and 2,140 ft. levels was started from the Central Shaft. In the Mindola section the excavation of the 1,420 ft. level pump chamber and settling sumps was completed, and by the end of the quarter the erection of the settlers, pumps, and switch-gear was well advanced. In view of the greater depth of the Central Shaft a second motor was installed on the service hoist and the gearing changed to give an increased rope speed.

By-products recovered at the Nkana Mine during the quarter included 1,728 oz. silver and 18,553 cwt. cobalt alloy. The cobalt alloy averaged 40·64 per cent. cobalt and 17·67 per cent. copper, and contained 7,540 cwt. of cobalt metal.

At the Roan Antelope Mine development from the Storke Shaft on the 1,440 ft. and 1,930 ft. levels and on intermediate levels in preparation for stoping was continued throughout the quarter. At the power station the erection of the No. 5 direct-fired boiler approached completion.

Zinc and Vanadium.—Acting upon the decision to proceed with the Lunsemfwa River hydro-electric power scheme at the Broken Hill Mine the survey and construction of the necessary connecting roads and the strengthening of existing bridges and culverts were undertaken. The new hoisting shaft reached a depth of 110 ft., and the erection of the permanent, electrically-operated, winding engines proceeded. In the Davis shaft excavation of the sumps, etc., was completed, and the installation of the settlers and main pumps well advanced. At the treatment plant an additional Glover acid tower was in course of erection.

During the quarter 17,419 tons of ore were treated at the Broken Hill Mine. This averaged 22·2 per cent. zinc, 4·0 per cent. lead and 0·4 per cent. vanadium pentoxide. From this 1,680 tons of electrolytic zinc, averaging 99·98 per cent. zinc, and 1,725 tons debased zinc, averaging 99·28 per cent. zinc, were recovered. The total recovery amounted to 3,405 tons, averaging 99·62 per cent. zinc, and containing 3,392 tons of zinc metal.

The company also treated 14,476 tons of vanadium ore averaging

1·36 per cent. vanadium pentoxide. This yielded 165·56 tons fused vanadium pentoxide containing 207,758 lb. vanadium metal.

Manganese Ore.—13 tons of ore, averaging 17·6 per cent. manganese, were mined at Chowa for use as a reagent in the production of zinc at Broken Hill.

Lead.—821 tons of sinter and ores averaging 25 per cent. lead were treated at Broken Hill and yielded 160 tons, averaging 99·8 per cent. lead.

NYASALAND

The following report of the work of the Geological Survey for the period July to December 1939 has been supplied by the Acting Director.

The Director of the Geological Survey, Dr. F. Dixey, O.B.E., left Nyasaland at the end of July, having been transferred to Northern Rhodesia as Director of Water Development,

The Geologist, Mineral Survey, resumed the examination of the Mzimba district in the highlands to the west of Lake Nyasa. The boundary between Nyasaland and Northern Rhodesia follows the watershed in this area. A general outline of the geology of this area was given in the report for July to December 1938 (see this BULLETIN, 1939, **37**, 118). A more detailed report will be published in the Geological Survey Annual Report for 1939.

In addition to his normal duties, the Geologist, Water Supply, acted as Director throughout the period under review. Water supply operations in the Kota Kota, Dowa, Dedza, Lilongwe, Upper Shire, Zomba and Chiradzulu districts were continued. A total of 55 dug wells and 7 bore-holes was completed during the 1939 season, and, in addition, one bore-hole was deepened and 2 dug wells and 2 bore-holes were in course of construction at the end of the year.

Prospecting of the Mlanje bauxite deposits was continued during the period under review and revealed that the amount of ore available is considerably in excess of the 20,000,000 tons estimated in 1924. The ore has proved to be of a commercially valuable grade, but owing to the introduction of new factors due to war conditions it is not yet known if the deposits are to be worked.

No new mineral deposits of any value have been discovered by the British South Africa Company in their areas in the Northern Province and further prospecting has been discontinued.

PALESTINE

The following information concerning the mineral industry of Palestine has been submitted by the Government Geologist.

Complete figures for 1939 giving mineral production and value are now available and are as follows :

	Quantity. Tons.	Value. £P.
*Potash (80 per cent. KCl)	63,527	381,162
*Bromine (refined)	589	46,528
*Magnesium chloride (44-45 per cent. $MgCl_2$)	167	668
Sulphur	842	4,304
Rock salt	645	852
Gypsum	4,524	1,000

* *Export only.*

In addition there were also produced 8,736 tons of sea salt valued at £(P)21,840, 112,350 tons of cement valued at £(P)200,000 and 191 tons of plaster of Paris.

The Survey Department during the year practically completed the geological mapping of ten sheets of the contoured 1 : 100,000 maps, the area covered including Beisan, Bethlehem, Gaza, Haifa, Jaffa-Tel Aviv, Jerusalem, Nablus, Safad, Tulkarm and Zikhron Ya'aqov. A general geological map of the country as far south as Gaza on a scale of 1 : 250,000 was also issued by the Survey Department.

The following table summarises the known mineral deposits of Palestine.

(*a*) Dead Sea	Potash, bromine, magnesium chloride: quantities virtually unlimited.
(*b*) Jebel Usdum Area	Petroleum: some seepages known.
	Bitumen: known deposits limited.
	Salt: quantity virtually unlimited.
	Gypsum (anhydrite): quantity large.
(*c*) Nabi Musa Area	Bituminous limestone: 10 sq. km.
	Phosphate: 100 sq. km.
(*d*) Yarmuk Area	Bituminous limestone: quantity not determined.
(*e*) Menahemiya	Gypsum: deposits in faulted strata, quantity unknown.
(*f*) Gaza	Sulphur: impregnation in sandstone, occurrence limited to one area of about 1 sq. km.
	Petroleum: several structures located but not tested.
(*g*) Akaba	Manganese: quantity not determined.
	Copper: occurs as a cupriferous sandstone, as veins of malachite and cuprite in sandstone and also in veins in igneous rocks in association with barytes and fluorspar.

Interest in prospecting for oil has been maintained but the presence of workable quantities has not yet been proved. The number of oil-prospecting licences in force is 31.

SARAWAK

According to the Chief Secretary, the reported production of gold for the period June 1 to August 31, 1939, was 4,897 fine oz., of which 28 oz. came from the Kuching District and the whole of the remainder from the Bau District. The increase over the previous three months amounted to 430 oz. The area covered by Mining Leases at the end of August was 6,149 acres, and, of the 38 leases extant, two cover quicksilver and the rest gold and silver. Eight exclusive Prospecting Licences for gold and silver, each

issued for a term of one year and covering in all 1,413 acres were in existence on August 31.

UGANDA

The following report has been received from the Director of the Geological Survey regarding mining activities in Uganda during the period October to December 1939.

Gold.—The output of gold has been maintained at much the same level as during the previous three months but the total export for the year has shown a slight decline, being estimated provisionally at 15,281 oz. of fine gold valued at £118,139, as compared with the 1938 export of 20,502 oz., valued at £146,286. This is due to the gradual working out of many of the large alluvial deposits of South-West Uganda. No new alluvial discoveries of note have been made and in no part of South-West Uganda have payable lode deposits been found. An attempt was made to work the low grade auriferous sandstones in the north-west corner of the Buhwezu plateau, but the deposits were proved unprofitable after a fair trial.

In the Eastern Province some small auriferous veins have been found on the Borderland area at Busia. As the two localities so far opened up are some 3 miles apart and the intervening rock assemblage is similar to that where the gold is now won, it is hoped that further prospecting will lead to the discovery of more veins.

The output of the Protectorate for the last three months of the year was 3,370 oz. of fine gold valued at £28,311.

Tin.—Although the figures for tinstone output during October-December are only half of those for the previous three months, the comparison is not a true index of the state of the industry, for the output has been very much hampered of late by the lack of rains and consequent shortage of water. No new areas have been opened up and by far the greater portion of the tinstone comes from claims that have been established for some years.

The output for 1939 was very similar to that for 1938 (444 tons, valued at £72,076, and 510 tons, valued at £70,143 respectively), and the slight decrease in tonnage was offset by the rise in price. The provisional export figures for the last three months of 1939 are 91 tons valued at £15,005.

Tantalite.—Some revival has taken place in the interest in tantalite owing to the offer by one firm of a good price for the ore. This however, has been proved to contain over 75 per cent. Ta_2O_5 and it seems unlikely that more occurrences of such high grade can be found. The tantalite in question is being won from a lode found by a member of the Geological Survey who has also found several other lodes worth investigation. The discovery of widespread tantalite in Southern Toro by the Manager of one of the prospecting companies suggests the probability that tantalite-columbite unmixed with tinstone should be found over an area

of nearly 1,000 sq. miles in this part of Uganda. Much therefore depends upon the marketing of the product and in turn upon the grade of the ore.

Oil.—A second deep hole near the hot springs at Kibero was stopped at 2,245 ft.; a new one is being drilled about a mile to the north.

ABSTRACTS AND NOTES

New Zealand Mining Industry, July-September 1939.—The following data regarding recent activity in the mineral industry have been supplied by the Under-Secretary of the Mines Department.

Auriferous Quartz Mining.—At the Martha Mine, Waihi, North Island, during the period July 2 to September 23, 1939, 47,361 tons of ore were treated, yielding 11,039 fine oz. of gold and 94,122 fine oz. of silver. In the South Island the returns from the chief mines during the same period were as follows:

Name of Mine.	Ore treated. *Tons.*	Gold produced. *Troy oz.*
Alexander	1,030	644
Big River	505	438
Blackwater	14,090	6,786

Gold Dredging.—In the West Coast District of South Island the dredge mining returns for the period July-September 1939 were as follows:

Dredges.	Cubic yardage treated.	Gold produced *Troy oz.*
Argo	138,500	484
Arahura	399,000	1,552
Barrytown	528,000	2,463
Blackball Creek	—	404
Bundi	79,418	251
Gillespies' Beach	179,742	365
Grey River	985,650	2,907
Kanieri	749,000	3,336
Mataki	136,200	319
Mataki Junction	177,000	604
Mossy Creek	52,756	253
Nemona	114,500	408
New River	103,700	609
Okarito	—	408
Rimu	480,475	2,187
White's Electric	84,180	304
Worksop	126,000	317

The Arahura dredge commenced operations on August 2, and the Bundi dredge ceased working temporarily on August 21.

In the Otago District the Clutha dredge produced 1,142 oz. and the Molyneux dredge 79 oz. It is not possible to give the yardage treated by these dredges, as owing to the difficulties of river dredging the buckets are rarely filled to capacity.

The Molyneux dredge operated five days only at the beginning of the quarter, as the low state of the river during the winter months causes suspension of operations. The falls ahead were too shallow for the dredge to negotiate. On September 25 the river had risen sufficiently for the dredge to pull upstream and it is now operating at intervals of every 200 ft. until the old Hartly and Riley claim is reached.

Manganese.—Mirandite Products Ltd. has suspended operations and applied for protection over its property in the Auckland Province while endeavouring to arrange finance for improvement of access to the area.

Several thousand pounds have been spent in connection with another deposit situated near Papakura, Auckland Province. Storage hoppers have been erected, tramways constructed and testing work carried out. The productive stage should be reached in a few weeks' time, and it is hoped to produce 70 tons daily. The deposit is fairly substantial.

The Stratigraphy and Structure of Turner Valley, Alberta.—An interesting study on the geological features of Turner Valley, Canada's principal oilfield, has recently been published under the title "The Stratigraphy and Structure of Turner Valley, Alberta," by G. S. Hume (*Can. Dept. Min. Res.*, 1939, paper 39-4. 19 pp.).

Turner Valley lies on the eastern edge of the Rocky Mountain foothills, to the south-west of Calgary. The sediments making up the stratigraphical succession consist of a basal limestone of Palæozoic age, overlain by alternating shales and sandstones with coal seams in the upper Tertiary measures, in all upwards of 9,000 ft. of rock. Oil-bearing sands occur in the Blairmore formation which varies between 1,050 and 1,200 ft. thick though the main oil horizons are in the Palæozoic limestone.

The Valley is demarcated on its eastern side by a strong fault which branches in the upper sediments and hence nowhere appears to have marked throw, but in the aggregate the displacement as proved in drilling has amounted to as much as 4,000 ft. The western side is similarly faulted, leaving the main anticline, the crest of which has been denuded to form the Valley, following a somewhat indeterminate course. It is this complicated faulting which makes the proving of northern and southern extensions of the main field such a difficult and expensive task.

Magnetometric Surveying of Hæmatite Ore.—Although hæmatite ore-bodies are commonly considered to be non-magnetic, instances have been recorded, as for example from Cumberland and South Wales, of the occurrence of measurable though small magnetic effects; in one case even where the ore-body was overlain by 200 to 300 ft. of country rock and alluvium, etc.

In Bulletin No. 2, *Geological Survey of Great Britain* 1939,

Hallimond and Whetton have described a systematic magnetometric survey by vertical variometers of parts of the hæmatite ore-bodies in South Cumberland and Furness, where an earlier survey by the electric resistivity method had failed to yield tangible results owing to the conductivity of the terrain being due mainly to the boulder clay. The accuracy and the sensitivity of the present method were first tested by traverses over ore-bodies known to exist from underground development. In cases such as these where only comparatively feeble magnetic anomalies are encountered, it is not sufficient to correct the field readings for diurnal and seasonal variations in terrestrial magnetism with simultaneous readings taken at a magnetic observatory any considerable distance away. Hence a local base for this purpose was established, as the nearest magnetometric observatory to the area under consideration was at Eskdalemuir.

The results of this survey, summarised by the authors, are that the present work has fully confirmed the original observation that the Cumberland hæmatite is appreciably magnetic. Under 60 ft. of cover it should be possible to detect the outcrop of a vein 15 ft. wide.

Very special caution is necessary in applying magnetic methods to this type of ore. (1) The values observed are much smaller than those due to most dyke rocks. In the past many surveys have been made with an accuracy of reading of $\pm$ 3 gamma, but with errors due to use of a distant base of the order of 10 gamma. Such accuracy would be practically useless for the present purpose. With the precautions here indicated a comprehensive accuracy of $\pm$ 2 gamma, or even $\pm$ 1 in shorter traverses, can be attained. It is only under these special conditions that magnetic prospecting for hæmatite should be undertaken. (2) The anomaly, being small, is comparable with those due to buried objects such as large boulders in boulder clay, or to magnetic country rocks. In every case such possibilities must be borne in mind; not only the size, but the distinctive form of the anomaly must be shown to correspond with that to be expected for the ore-body whose presence is deduced. It would be quite inadmissible to bore on every " high " on the assumption that an ore-body will be present.

The local results may be summarised as follows. Trials with a vertical magnetic field balance were made over an elongated body of hæmatite ore, known to have a cross section of about 50 ft., a depth of 100 ft. and a cover of about 60 ft. of boulder clay, situated near Red Hill Farm, Millom, Cumberland. An anomaly of about 30 gamma was observed. Using precise methods, a detailed magnetic survey was then made of a neighbouring area about 1,000 ft. square. A parallel elongated anomaly was located, similar to that found in the first trials, and this is associated with an ore-body, which, so far as it has been explored, is closely comparable with its previously-known neighbour.

Ore Reserves.—In view of the importance which naturally attaches to the precise meaning of the term "ore reserves" and similar expressions in mining reports, the paper on this subject by J. H. Fennell (*Bull. Inst. Min. Met.*, No. 422, Nov. 1939), together with the subsequent discussion and the expression of the views of the council of the Institution, are of great interest.

The author has defined some of the terms more frequently used as follows:

Total extractable ore in a metalliferous deposit may be defined as all the ore within the boundaries of the deposit which can be reached by development and extracted at a profit. It thus has two aspects, which can be expressed by dividing it into two classes, namely:

1. Exposed and partially exposed ore, that is (*a*) ore blocked out, and (*b*) probable ore, and
2. Ore which is not exposed anywhere, that is (*c*) prospective ore.

It is rarely possible to estimate the total prospective ore in a deposit, and by the general term "prospective ore" will be meant that part of the unexposed ore remaining in a deposit of which an estimate can be made based on expectancy. Such an estimate represents the partial speculative value of a mine.

Ore blocked out is ore exposed on three or four sides, ready for extraction, the exact amount of which can be calculated by simple numerical rules.

Probable ore is ore continuous with the above, exposed on two sides, occasionally on one side only, for which up to the limits decided upon there is normal expectancy. Probable ore thus differs from ore blocked out in that the amount estimated depends in some small degree upon the judgment of the engineer making the estimate. The estimate is liable to be vitiated by unforeseen variations in the local geology, though this possibility will be minimised by conservative assumptions for the extension of the ore behind the exposed faces. Probable ore is ore the expectancy of which is so good that it can almost always be bracketed with the ore blocked out, the essential difference between the two kinds of ore being that the latter is ready for stoping while the former requires some further development before it can be extracted.

Prospective ore is ore which is not exposed anywhere and therefore cannot be included in the estimates of the ore (blocked out and probable) the profit on which represents the value of a mining property as it stands, but of which an estimate of tonnage and grade should be given, wherever practicable, as an expression of the speculative value of the mine. It is ore for which there is reasonable expectancy, based on previous exploitation of the deposit, a study of the local geology, and a comparison with other mines being worked in the district, if such exist. Prospective ore

is taken as occurring within the probable boundaries of the deposit and estimates of tonnage and grade are partial and of a provisional nature, and may be conveniently specified between upper and lower limits. It may be possible in some cases to fix an approximate depth to which the ore-body may be deemed to persist. Two chief objects in making an estimate of prospective ore are to approximate to the tonnage of pay-ore which can be developed per 100 ft. of depth, and forecast the probable minimum " life " of the mine.

The estimation of proved ore and prospective ore should theoretically perhaps be kept separate. This, however, causes some difficulty, as the prospective ore is directly related to the exposed ore and the quantities of prospective ore estimated are largely dependent upon the quantities of ore which have been developed.

The Institution has further drawn attention (*Bull. Inst. Min. Met.*, No. 423, Dec. 1939) to the fact that " ore in sight " is frequently used to denote two entirely separate factors:

(*a*) ore blocked out—ore exposed on at least three sides within reasonable distance, and

(*b*) ore reasonably assumed to exist though not actually blocked out.

As many of these terms were formerly given wide and liberal interpretation, the more precise definition of their connotation will be generally welcomed as a timely addition to technical phraseology.

Brucite in Canada.—Although magnesite is the principal raw material for the manufacture of magnesia and magnesium metal, brucite (magnesium hydroxide) can also be employed, and the development of deposits of this mineral in Canada is of great importance, particularly at a time like the present when the mineral resources of the Empire form such a valuable asset. The Canadian deposits, which are located in Quebec and Ontario, were first examined in 1937 and are briefly described in the recent Imperial Institute monograph on *Magnesium, Magnesite and Dolomite.* A complete report on the deposits has now been published by the Division of Mineral Reposits, Quebec Department of Mines, under the title of *Brucite*, by F. Fitz Osborne (*P.R.* 139, Quebec, 1939).

Brucite is a soft, white or pale-buff mineral with the formula $Mg(OH)_2$. It is found in small masses with irregular crystal structure in limestones of the Grenville Series at Bryson, Pontiac County, Quebec, at Wakefield and Farm Point, Hull County, Quebec, and at Rutherglen, Ontario. The crystal aggregates are from one-twelfth inch to half inch in diameter but the average may be taken as one-eighth inch. Many show a concentric structure which is apparent on naturally or artificially etched surfaces. The brucite weathers more than the associated carbonates so that a pitted surface develops on the outcrops, a feature that is of considerable assistance in prospecting. On a surface that has been

exposed for only a few weeks, the brucite becomes chalky-white by development of hydrous magnesium carbonate.

There are a number of occurrences on both sides of the Gatineau river in Pontiac county, about 14 miles from the city of Hull, but geological maps of the area serve more as an indication of the occurrence of formations in the district than of their true distribution. This is particularly true of the Grenville crystalline limestones of which the outcrop areas are exaggerated. In the region near Wakefield and Farm Point, many of the exposures of limestone show brucite. In the thicker bands, brucite appears to be more abundant in the lower parts, thus, on the head of a tadpole-shaped outcrop of limestone near Wakefield the brucite is less conspicuous toward the top of the hill than at the bottom, the higher-grade brucite rock being found close to the granite on the lower side, or footwall, of the limestone.

It is suggested that the higher-grade brucite rock was formed on the lower sides of the limestone bands close to the granite, and that occurrences higher in the series are likely to be sporadically distributed. It is important to establish the thickness through which the high-grade material is likely to extend. Detailed, geological mapping, possibly supplemented by diamond drilling would be necessary to provide a thoroughly reliable estimate of this but the data so far available suggest that the deposits extend at least 60 ft. upward from the granite and possibly as much as 140 ft. This, however, does not imply that any occurrence of brucite-bearing limestone is likely to continue to those depths, because some of the outcrops are thin and overlie silicate rock, and, in most of the exposures, some brucite rock has been eroded away.

In the district surrounding Wakefield township two outcrops of brucite-bearing rock occur on the road on the south side of a till-covered ridge south of the school. Nearer the Gatineau River and about 2 miles south-west of the outcrops mentioned above, brucite has been observed in a limestone bluff, but the exposure is not large enough to enable the extent of the brucite-bearing rock to be determined. If further examination should disclose an important body, quarrying would be a simple matter, but transportation to the railways would be difficult. Half a mile east of this a road trending south crosses and is flanked by outcrops of coarse-grained granite and syenite of the Pine Hill group. Brucite-limestone occupies a narrow rim of the valley, flanking the granite and overlying the clay at the bottom of the valley.

The above deposits, which are all east of the Gatineau River, can be worked only near the lower levels of the valleys and material must be transported across the river to the railway. The deposits described are from 2 to 5 miles from the railway siding at Wakefield and the present load-limit on the covered bridge across the river above Wakefield is 4 tons. The occurrences are, however, of interest as indicating the presence of brucite in the area, and it is

possible that further prospecting would show larger and more favourably situated deposits.

West of the Gatineau, outcrops of Grenville limestone on both sides of the road west of Wakefield show some disseminated brucite. A more or less isolated exposure of brucite-bearing limestone in an area about 300 ft. long and 100 ft. wide has been stripped preparatory to opening a quarry. Supplementary pits sunk at intervals to the south of the stripped area show some brucitic material and much serpentine but the tonnage available has not yet been ascertained. Assuming, however, that the band is 300 ft. long and 100 ft. wide and extends to 60 ft. in depth, the reserves will amount to 30,000 tons of brucite. The whole extent of the band has not been stripped and it is probable that the area is greater than that stated, so that a tonnage possibly twice as large may be present.

The original discovery of brucite in this area is on the north slope of a hill overlooking Meach Brook where a small quarry has been opened for experimental purposes. Brucite-limestone is exposed in places in an area a little more than 300 ft. long by 200 ft. wide. The rock contains a high proportion of brucite and the area probably underlain by brucite is about 65,000 sq. ft. over which the rock should contain about 900 tons of brucite per foot in depth. On account of its position on the flank of a hill it is difficult to estimate the thickness of the brucite bed but at the quarry the thickness is about 30 ft. and probably increases to the east. An average thickness of 50 ft. is probable and the area may be estimated to contain 45,000 tons of brucite.

About 1 mile to the south-east a number of occurrences of brucite-limestone are found, this being probably the most promising locality for the production of the mineral. A ridge of Pine Hill formation separates this mass of limestone from the previous deposit but a number of areas of brucite-limestone are exposed to the south and south-west. On the west and south-east sides pyroxenites have been worked extensively for mica and on the west side a band of brucite-limestone dips 60° beneath the pyroxenite. The brucite is exposed over an area equivalent to about 420,000 sq. ft., indicating, with an assumed depth of 60 ft., reserves of about 360,000 tons.

Several exposures occur to the south-west, the most conspicuous forming a knoll east of the road. Serpentine and pyroxenite occur on the west side of the mass, which dips east, and the eastern extension is drift covered. These occurrences differ from those described above in that there is an interbanding of brucitic and non-brucitic material so that, if the whole mass were quarried, the grade would be lower than that of the other deposits. In some places there are brucitic layers 10 ft. thick but generally the banding is on a much smaller scale. It is impossible to estimate the total quantity of brucite available.

The deposits on the west side of the Gatineau River are more favourably situated as regards both quarrying and transportation

than are those on the east and three of the deposits could probably supply about 400,000 tons of brucite between them. Considerable reserves in other occurrences which are less favourably situated, and the strong possibility that other deposits may be found in the area, make it probable that, if necessary, 1,000,000 tons of brucite may be found. The district is by no means thoroughly prospected and more detailed work would undoubtedly disclose additional deposits.

In the Columet Island region deposits of brucite were discovered in Carswell's quarry, near the south end of the village of Bryson, Pontiac County, by M. F. Goudge, but their general lenticularity makes them less favourable for development than those of the Gatineau region and the low angle of dip would strictly limit quarrying operations.

In the Province of Ontario, brucite deposits near Rutherglen have been described by M. F. Goudge. The deposits are on Talon Lake and near Crooked Lake, and their proximity to the Quebec boundary makes them of interest. The Rutherglen deposits resemble those at Wakefield, the granite gneiss probably forming part of the same series as the Pine Hill type at Wakefield. The deposits in the two principal Quebec localities and that near Rutherglen are all formed in bands of Grenville limestone; those at Wakefield and Rutherglen are practically surrounded by granitic igneous rocks belonging to the Pine Hill group of the Morin series and Pine Hill rocks occur near the deposits at Calumet.

Alsifilm.—The limited distribution and extent of the world's resources of high-grade mica, particularly of the qualities and sizes which can be classed as munitions grade, has led to innumerable attempts to find satisfactory substitutes for sheet mica. Prominent among these are the sheets, known as micanite, which are built up from small mica splittings suitably bonded together. Synthetic resin insulating materials constitute the other important class of alternative substances.

None of these products, however, possesses to the same high degree the refractory,* insulating and dielectric properties of the natural mineral and they can, therefore, only be utilised where great heat and high voltages are not encountered.

Of the highest importance, therefore, to both the mica-producing and mica-consuming industries was the appearance in 1938 of the synthetic material called mnemonically Alsifilm (aluminium silicate film) which, though still in the experimental stages, has already shown that it has possibilities that, if realised, may make it a serious competitor of naturally-occurring mica.

Such a development is naturally of the greatest importance at the present time when extraordinary demands are being made upon the capacity of mica producers to supply the needs of industry. In addition, the raw materials from which Alsifilm is made may

occur abundantly in some of those countries which are deficient in natural resources of the highest qualities and largest sheets of mica.

Contrary to statements which have appeared in print, however, Alsifilm is not yet definitely established on the market, and in view of the sensational nature of some of these statements the Research Corporation of America, who administer the patent rights on the inventions relating to this product, have decided to clarify the situation as to the stage of development which the product has reached. The Corporation points out that although the potential importance of Alsifilm is considerable, it cannot yet be regarded as having passed from the laboratory stage to that of commercial exploitation, and that even under the most favourable circumstances at least a year and probably more must elapse before the material can be placed on the market. No considerable supply has, therefore, yet been made generally available and the quantities being produced at the Massachusetts Institute of Technology only suffice for experimental and development purposes. Negotiations have, however, been entered into with certain organisations both in the United States and elsewhere, who are in a position to collaborate in the development of the material.

The discovery of Alsifilm was made by Dr. E. S. Hauser as a result of investigations with Dr. E. S. Le Beau at Massachusetts Institute of Technology, into the mechanism of the formation of gels and of films produced from them, using colloidal clays (*J. Phys. Chem.*, **42**, No. 7, 1938, p. 961). Specifically, the mineral montmorillonite of the bentonite group was used as the raw material. These workers found that gels prepared from bentonite would desiccate and harden slowly at little more than atmospheric temperatures, that films made from these gels were resistant to high temperatures, oils and organic solvents, and that they possessed encouraging electrical properties when dry. According to these authors no specific alignment of the disperse phase could be detected ultramicroscopically in freshly-prepared, extremely-dilute ($<\cdot 1$ per cent.), monodisperse sols of montmorillonite, which disproves the theory that gels necessarily take the form of chain-like aggregates. In addition to concluding that the formation of these gels is caused by the taking up of positions of equilibrium by the particles, the authors show that the transition from sol to gel is accompanied by the development of a three-dimensional, interwoven, crystalline structure which, when completely or nearly completely dry, attains sufficient mechanical strength to be self-supporting when removed from the support on which it was deposited. It is confirmed, however, that in this woven fabric type of structure the individual filaments or threads themselves consist of aligned or chain-like aggregates.

The significant point in this process of making thin films is that no extraneous binding medium is required. It is the presence of such binders with their necessarily lower refractory and insulating

properties, and sometimes the irregular distribution of the binder, which is the weak link in mica substitutes of the micanite type. It should be noted, however, that even with Alsifilm, where very thick sheets are required, these, too, will have to be built up by bonding thinner sheets together, with consequent deterioration in quality.

Of interest to mineralogists is the fact that although Wyoming bentonite was used in the original investigations and bentonites from other sources in later experiments, very similar results can be obtained with other clays and even with vanadium pentoxide sols. Clays of which 75 per cent. or more is in the colloidal condition and which possess the property of rapid dispersion, have been found to be most suitable for the preparation of these films.

Particle size in the basic raw material is of paramount importance and, previous to gelling, all impurities and particles larger than those of colloidal size, are removed either by sedimentation or by supercentrifuging. As will be readily appreciated, the flexibility and degree of moisture retention also varies directly with particle size.

After removing the oversize particles, the aqueous colloidal suspension of the bentonite in about 50 times its volume of liquid is concentrated, originally by centrifuging but more recently by evaporating, to about 6 to 10 per cent. solids. From this gel the films can be made by such hand methods as extrusion, spreading and painting, but for production on the commercial scale a continuous process of deposition, either on metal or fabric supports, is contemplated. The removal of the retained moisture is one of the problems which is being intensively investigated, as the mechanical and electrical properties of the film are naturally closely related to the degree and method of drying. In order to overcome the cracking and distortion which take place when the surface of the film dries first, other methods of desiccation are under consideration, notably the use of infra-red rays which commences the drying process from the interior of the film. Different temperatures of drying are also being tried. When dry the material is treated with certain reagents in order to improve its flexibility and its resistance to water.

Detailed data concerning the physical and electrical properties of Alsifilm are not yet generally available, but it is said that the films can be made in thicknesses ranging from 0·001 in. to 0·005 in. It is not claimed for this synthetic product that it has the transparency of the best clear mica, but it is interesting to note that not only can the translucency be partially controlled but also the stiffness and the colour of the finished film can be regulated by the introduction of various fillers and pigments into the gels.

These properties, however, do not place Alsifilm in competition with natural mica and publication of the dielectric constant, specific resistance, breakdown strength and power factor as compared with

mica, are awaited with greater interest by all those concerned with the production and utilisation of naturally-occurring mica.

Gold in the Yukon.—An important development in the gold mining industry of the Yukon has been announced by the Dominion Department of Mines and Resources. During 1938 an ingot of crude gold weighing 84 oz. was produced at the Laforma Mine in the Freegold Mountain area in the Carmacks district. This was the first production of the area, and the first production of lode gold in the Yukon for many years. It is anticipated that the Freegold Mountain area may become the third important producing region of the territory with an average monthly output of 300 to 400 oz. per month. During the first quarter of 1939 approximately 250 oz. of fine gold were produced, including bullion and concentrates. Lode gold mining has thus been established in the territory, previous gold " rushes " being based on alluvial gold.

On the Klondyke River and its tributaries in the vicinity of Dawson City, considerable activity is being carried on by the Yukon Consolidated Gold Corporation, Ltd., which is the only large-scale placer mining operation of this type in Canada. These operations are described by W. H. S. McFarland in the *Canadian Mining and Metallurgical Bulletin* (No. 331, Nov. 1939, p. 537). In 1938 the company had 1,650 placer mining claims and 9 leases or concessions covering approximately 1,000 sq. miles and had nine bucket dredges in operation ; two more have since been constructed and one dismantled, leaving ten in operation.

The gravel reserves proved by detailed drilling are calculated at 92,000,000 cu. yds., containing gold to the value of $41,000,000. In addition to the proved reserves the company holds a considerable area of ground as yet unprospected. Future operations are planned to average 4,150,000 cu. yds. a year, and this should give the reserves a life of approximately 22 years.

The success of the Yukon Consolidated enterprise is due largely to the development of low-cost methods of production. One factor in cost reduction has been the application of a method, developed in Alaska, of thawing frozen gravel by water at natural temperatures instead of by steam. Pipes are driven down to bedrock and water is circulated for periods of from two or three weeks to a few months, depending on the particular circumstances (*Min. Mag.*, 1939, **61**, 120).

Once the overburden has been removed the dredging itself does not present great difficulties. The gravels are for the greater part comparatively shallow, seldom being deeper than 10 ft., except in the Klondyke river valley where they average 30 ft. In ground which is all frozen the dredging costs average 15 to 20 cents per cu. yd., which is surprisingly low considering the necessity of stripping and thawing nearly all the ground treated.

Gold was first produced from the Yukon over 50 years ago,

in the middle eighties, though the first considerable output was 120,900 oz. in 1897. The highest output came in 1900 when the amount produced was 1,077,500 oz. In this year the total Canadian output amounted to 1,350,000 oz. The lowest point of production was reached in 1926, with an output of 25,600 oz., since then there has been an upward trend. In 1938 the Yukon produced 72,500 oz. of the total Canadian output of 4,715,400 oz. With new developments in hand it is possible that in future years the Yukon will once again be responsible for a large share of the Canadian gold production.

Production of Potassium Sulphate from Sea Water.—Although the actual percentages of salts other than sodium chloride present in sea water are very small, in the extraction of salt from sea water on a large scale, the total amounts of these compounds left in the mother liquors are considerable. These mother liquors are usually thrown back into the sea. An American process, in use on the coast of California, for extracting magnesium compounds from them was recently described in this BULLETIN (1938, **36**, 523).

A process has also been worked out, mainly in Italian East Africa, for the extraction of potash salts from sea water bitterns, with a view to rendering Italy, which has no natural deposits of potash salts, less dependent on imported potash. The process was tried experimentally near Naples, and in 1933 the Società Italiana Saline Eritree began the erection of a plant at Massaua, Eritrea, for the production of potash salts in conjunction with the salt works already established there (*Relaz. Serv. Min.*, Rome, 1933, 221). The Italian war with Ethiopia interrupted the project, but the construction of the large-scale plant is stated to have been completed by the end of 1936 (*Chem. Tr. J.*, 1937, **100**, 356). The work is being carried out in conjuncrion with the Società Italiana Potassio Marino and a description of the plant at Massaua has been given by Niccoli, the originator of the process used (*La Chim. e l' Ind.*, 1936, **18**, 557-563). The installation is intended to deal with the whole of the mother liquors from the salt-extraction works, which can produce up to 1,000,000 quintals of salt annually. This will mean a possible production of about 30,000 quintals of potash salts, containing up to 50 per cent. of potassium sulphate, per annum. Other plants of the same type are also projected.

The process used is that devised by Enrico Niccoli, and involves three stages. In the first stage the mother liquors at 30° Bé, usually thrown back into the sea, are concentrated by solar heat in a series of pans up to 35° to 37° Bé, impure sodium chloride deposited at a lower concentration being removed. At this density, a mixed salt called " mellahite " is deposited. Owing to the effect of slight variations in conditions in the evaporating pans, such as change of wind, prolonged calm, alteration in temperature, it has been found impossible to keep the composition of the deposited mellahite

absolutely constant, but it is approximately as follows: potassium chloride, 18 to 21 per cent.; sodium chloride, 17 to 22 per cent.; magnesium sulphate, 29 to 33 per cent.; and magnesium chloride, 2 to 4 per cent.

The mellahite is usually left in heaps on the ground for two or three months, and then in the second stage of the process it is ground, automatically weighed, and carried to refineries where it is washed with sea water at a suitable concentration and temperature, schoenite, $K_2SO_4 . MgSO_4 . 6H_2O$, being produced.

The crude schoenite passes to a centrifuge, where it is freed from water, giving a product containing about 38 per cent. potassium sulphate and 1 per cent. potassium chloride. This is sent to a dehydrator, where it is subjected to a temperature of about 170° C., thereby losing its water of crystallisation and giving "Niccoli potash salt" with 50 per cent. of potassium sulphate. At the present time this is the chief product.

These "Niccoli potash salts" show considerable resemblance to the German potash fertiliser "Kalimagnesia" as can be seen from the following table:

	Niccoli potash salts. *Per cent.*	Kalimagnesia. *Per cent.*
Potassium sulphate, K_2SO_4	51·0	50·4
Magnesium sulphate, $MgSO_4$	37·9	28·0
Sodium chloride, NaCl	3·1	3·5
Calcium sulphate, $CaSO_4$	—	3·4
Water	4·6	7·1
Insoluble	3·0	7·6

Since Kalimagnesia has been in use as a fertiliser for a long period, the value of Niccoli salts for the same purpose is regarded as already proved.

The third stage of the complete Niccoli process involves the solution of the schoenite, before dehydration, in a large volume of fresh (non-saline) water. Milk of lime is added in order to precipitate the magnesia, together with calcium sulphate, and the potassium sulphate is left in solution. A product of up to 95 or 96 per cent. purity can be recovered from this solution.

Variations in the composition of the mellahite obtained do not materially affect the efficiency of the second stage of the process, i.e. producing the potassium magnesium sulphate, but they would have an adverse effect on the purity of the final potassium sulphate. Further refining of this product would add unduly to the cost. The final stage is, however, only of limited interest at present, as the Niccoli process is being worked mainly at places where no supplies of fresh water for the production of potassium sulphate from the schoenite are available.

It appears probable that special climatic conditions may be required for the complete economic success of this process. At Massaua, the liquors can be circulated by gravity, owing to the

favourable site conditions, and the evaporation of the solutions for the deposition of the mellahite is all carried out by solar heat. A survey made to determine whether the process could be used in the Western Hemisphere led to the conclusion that it could probably be operated on the Atlantic coast of Colombia, South America, but that proper climatic conditions for economic operation do not obtain in the United States (*World Tr. Notes on Chem., etc.*, Feb. 2, 1935, **9**, 3).

The Italian plants operating the Niccoli process are stated to be working successfully and are said to possess an annual production capacity of between 15,000 and 20,000 quintals of the double potassium magnesium sulphate (*Chem. Tr. J.*, 1939, **104**, 590). It is believed that by further adoption of this process, Italy will be able to realise virtually complete independence of imported supplies of potash for fertilisers.

Bleaching Clays.—An interesting account of the nature and uses of bleaching clays is given by G. Austin Schroter in *Engineering and Mining Journal*, Nov. 1939, pp. 35-38, 40.

A naturally adsorptive clay can be regarded as a clay which, without treatment, is capable of decolorising oils. The economic value of such clays is dependent on arbitrary standards of efficiency established by various industries. As requirements change with time, so the demand for particular clays varies, and hence a natural clay which now commands a certain value may prove of little use when another clay of greater efficiency is discovered. Naturally adsorptive clays have the peculiar property of being selective in action, e.g. one may be well suited for bleaching cotton seed oil but useless for decolorising lubricating oils. There is no universally efficient naturally adsorbent clay.

Certain clays are capable of being activated, that is, their latent adsorptive properties can be improved by chemical treatment. This process usually necessitates leaching the clay with acid, which is subsequently removed by washing. Activated clays are usually more efficient over a wide range of substances than are good natural clays, so that a smaller quantity of the clay is required to effect decolorisation, filtration is quicker, and less oil is retained in the filter cake.

Bauxite, which the author terms a natural semi-adsorptive clay, has bleaching properties which are highly preferential, and which limit it to the treatment of certain types of petroleum oils. Careful heat treatment of the bauxite produces a material of somewhat higher efficiency which in consequence of the low cost of production, finds a considerable market in the fields where it can be utilised.

Although new applications for adsorbent clays are continually being discovered, their biggest outlet is in the petroleum refining industry, where two methods of treatment are still in general use.

One of these is the percolation method, in which a column is filled with carefully sized bleaching clay, through which the material to be treated, either in the liquid or vapour phase, passes. In order to produce an earth of requisite grain-size, the natural material is usually screened, but as the undersized particles are of little value a process has now been developed whereby pellets can be manufactured from a slurry of clay and water. This is dried until it attains the consistency of a stiff dough and is then extruded through a perforated annular die and cut into short lengths by means of rotating knives.

The second method of treatment, which has now been used for many years for certain oils such as lubricating oils, edible oils, fats, waxes, hydrogenated oils and oleomargarines, consists in agitating the oil, at an elevated temperature, with predetermined amounts of bleaching earth. After a given period, which varies with different oils, the oil and earth are then filtered as quickly as possible, a decolorised product being thus obtained, the impurities being left behind in the filter press with the spent clay. In some cases, after the agitation is completed, the oil is filtered through vacuum filters, the drums being lightly coated with diatomaceous earth or similar material.

A recent advance in the utilisation of bleaching earths has been the development of the patented "fractional purification" process, in which the finely-ground activated earth is added to the hydrocarbon oil and both are passed into the still, where the oil and activated clay undergo the normal fractionating distillation. In this way the various fractions passing through the fractionating tower are decolorised and purified in one operation.

Perhaps the latest development in the application of adsorbent clay is found in the catalytic refining of petroleum oils. In the old method of refining crude oil, the light oil fractions were first removed by distillation, and the heavier hydrocarbons remaining were broken up by thermal cracking at a pressure of 1,000 lb. per sq. in. and at a temperature in the region of 1,100° F. Even under the most favourable conditions large quantities of heavy fuel oils, asphalts and other products, of low commercial value, were left behind. By the use of adsorbent clay, catalytic cracking takes place at a temperature of about 900° F. and under pressures of only 20 to 40 lb. per sq. in. Moreover, 50 per cent. of the heavy residues which would normally remain after treatment by the old process are converted into petrols having a natural octane rating of 78-81, a standard which compares favourably with that of the highest grade of motor fuel.

With regard to the nature of the adsorptive clays, the author states that the naturally adsorptive clays are usually altered clastic sediments, while the activable clays are usually, but not always, altered bentonites, montmorillonite being nearly always the dominant constituent.

" Mineralisers " in Cement.—In the manufacture of normal portland cement a raw mix that will give a total of 8 to 10 per cent. of alumina and ferric oxide is usually selected, as these two oxides act as fluxes and bring about clinkering and complete combination of the cement compounds at temperatures economically attainable in commercial practice.

It is known, however, that reactions involving the alumina and ferric oxide compounds of portland cement are partially responsible for the disintegration of concrete when exposed to sea water or sulphate solutions. Attempts to overcome this difficulty have been directed towards an endeavour to reduce the ferric oxide and alumina to about 3 per cent., and to promote the formation of silicates by the addition of a catalyst or " mineraliser."

E. P. Flint, in an article in *Rock Products*, October 1939, p. 40, describes an important practical investigation into the problem of the acceleration of silicate formation in cement, and records some very interesting results.

The mineralisers employed in this work included magnesium fluosilicate hexahydrate, calcium fluoride, calcium phosphate, boric acid and cryolite. Boric acid and calcium phosphate were found to be unsuitable, their addition to tricalcium and dicalcium silicate mixtures tending to produce excessive uncombined lime in the cement. Calcium fluoride reduced uncombined lime in both tricalcium and dicalcium mixtures, although the addition of 1 per cent. of natural cryolite was found to be more effective. The experiments with cryolite were not extensive as the results of similar work with this mineral were already available. The most striking results were obtained from those experiments which involved the addition of a small quantity of magnesium fluosilicate to the raw mixtures. This mineraliser effected great reductions in the amount of uncombined lime contained in the final product, compared with similar mixes to which it was not added. The addition of 2 per cent. of magnesium fluosilicate to a tricalcium silicate mixture reduced the uncombined lime in clinkers burnt at 1,400° and 1,450° C. to about one-fifth of the amount found in those mixtures in which no magnesium fluosilicate was present, and in addition the tricalcium silicate content was raised by 50 per cent. Further successful experiments involving the use of small quantities of this mineraliser in various tricalcium and dicalcium mixtures from which the ferric oxide had been partly or wholly eliminated are described in detail.

The author suggests that the use of magnesium fluosilicate as a mineraliser for cement mixes may have the following useful applications, in addition to its possible employment for reducing the ferric oxide and alumina content of sulphate-resistant cements.

In the manufacture of normal portland cement, it should accelerate the rate of reaction of lime and silica and thus lower the temperature and time of burning.

In burning white portland cement mixes, it should facilitate complete combination of lime and silica, and reduce the rather high kiln temperature which has hitherto been necessary.

Magnesium fluosilicate is a cheap industrial chemical, obtained as a by-product in the manufacture of phosphoric acid and superphosphate fertiliser. It is extremely soluble and could easily be added to the cement slurry in the wet process; for the dry mixing method of cement manufacture it can be readily introduced in powder form. It is extremely active, only about 1 per cent. being necessary, this amount increasing the total magnesia content of the finished cement by only 0·24 per cent.

Luminous Pigments.—Substances which have the power of emitting previously absorbed light have recently attracted considerable attention because of their applications in luminous paints, the demand for which has grown abnormally owing to the present black-out regulations. Recent published information on the subject may be found in articles by V. Demant and O. Petzold in the *Oil and Colour Trades Journal* (1939, **95** and **96**, May 5 to Aug. 4), by H. Courtney Bryson in the same journal (1939, **96**, Nov. 17 to Dec. 29; 1940, **97**, Jan. 5 to 19) and in a small note in the *Chemical Age* (1939, **41**, 400). The production of the "luminophore," or luminous base, involves considerable skill and difficulty in view of the extraordinary precautions which have to be taken to prevent the slightest contamination during manufacture.

Many types of luminous pigment are in use, the commonest group containing the sulphides of barium, strontium, calcium, zinc or cadmium or mixtures of these. The sulphides, which have to be prepared in an exceedingly pure form, are not inherently luminous but have added to them a small proportion of a compound of certain metals or rare earths which confers luminous properties. A flux consisting of the sulphates, carbonates, phosphates, borates, chlorides or fluorides of the alkali and alkaline earth metals is also added and the mixture ignited, cooled and disintegrated. The disintegration of the sintered mixture after ignition is difficult. Fine grinding destroys the luminosity, so heating with high boiling non-reactive liquids which promote disintegration is often used instead, or the sintered mixture is ground and given a short heat treatment at a lower temperature to restore the activity. Alternatively, magnesium carbonate, aluminium oxide or beryllium oxide may be added to minimise hard sintering.

The activity of the luminophore is affected by the temperature of ignition and the rate of cooling and, in general, a rapid rate of cooling is desirable. Many products of differing luminosity are obtainable, visibility in darkness up to a distance of about 100 yds. being common. The pigments are activated or charged by natural or artificial light, about 5 minutes' exposure in the former and 20 or 30 minutes in the latter being required in order to secure full

activation. When the pigment is correctly applied, the luminosity or "after-glow" is effective for a period of about 25 hours.

The luminophores may be added to a leadless white paint, such as zinc or titanium white, with a neutral base and solvent. White lead is not used as the presence of even the smallest quantity of lead greatly reduces the intensity and active life. An excess of heavy covering pigment is also to be avoided. The best results are obtained by using the pigments alone in a clear neutral varnish, adding approximately 40 per cent. of powder to the transparent medium. The best media are those composed of synthetic plastic materials such as methyl acrylite, benzyl cellulose or chlorinated rubber, with such solvents as toluol, xylol, benzol or alcohol. Cellulose acetate may be used but it is not recommended as many commercial supplies are slightly acid.

The surface to be treated is first given a coat of leadless white, preferably in a similar medium to that used for the luminous pigment. Two coats of the latter are then applied followed by a protecting over-varnish. The most suitable colours are green, blue and violet which have the longest period of intensity after activation. Red, orange, yellow and light green are also available and have a greater initial intensity but shorter active life.

Other types of luminous pigments, stimulated by ultra-violet and cathode rays and with a rapid loss of activity, are employed in electric discharge tubes and for television screens. Such pigments are mainly silicates of zinc and mixtures of zinc and cadmium silicates, although magnesium and beryllium compounds are often used. If luminous paint is required to maintain a constant activity for clock and instrument dials, a radio-active material containing radium or mesothorium is incorporated in the paint.

Luminous screens fluorescing under the influence of X-rays have usually been coated with barium platinocyanide, which is an expensive material, but recently silicate and sulphide luminous pigments have been successfully used as a substitute. The detection of infra-red rays by means of luminous pigments is of practical interest and depends on the fact that the incidence of such rays on phosphorescent material causes luminosity to be either considerably increased or completely quenched depending upon the type of pigment used.

The efficiency of electric discharge lamps is increased by the use of luminous powders. The lamps emit a considerable amount of ultra-violet light which is transformed into visible light of various colours when it passes through layers of fluorescent materials coating the wall of the bulb. Thus, for example, the unpleasant colour of the light emitted by the mercury vapour lamp can be masked by a judicious choice of luminous materials. Luminous powders can also be fused into vitreous enamels and embodied in synthetic resins yielding luminous materials which can be used in the manufacture of switch covers and similar objects.

A British Standard specification for Fluorescent and Luminous Paint for A.R.P. purposes (No. A.R.P. 18) has recently been published. This describes a standard test for the activity and life of such paints and includes an appendix of general information with suggested uses of luminous paints in solving various A.R.P. lighting problems.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

MINES OF AFRICA. Industries, Banking, Travel. 1939-40 Edition. Edited by C. Carlyle-Gall and H. Naughton Knebel. Pp. clv + 1,055, $8\frac{1}{2} \times 5\frac{1}{2}$. (London and Johannesburg: African and Rhodesian Mines Publishing Co., Ltd., 1939.) Price 30*s.* (post free in the U.K., 31*s.*; post free abroad, 32*s.*).

MINES OF RHODESIA. Industries, Agriculture, Travel. 1939-40 Edition. Edited by C. Carlyle-Gall and H. Naughton Knebel. Pp. clv + 845, $8\frac{1}{2} \times 5\frac{1}{2}$. (London and Johannesburg: African and Rhodesian Mines Publishing Co., Ltd., 1939.) Price 30*s.* (post free in the U.K., 31*s.*; post free abroad, 32*s.*).

Mines of Africa and *Mines of Rhodesia* are something rather more than mere catalogues of mining companies; they are comprehensive reference books in which information pertaining to all aspects of the mining industry in the African continent may be found.

Mines of Africa, in the introductory section, contains a list of companies controlled by the various large financial groups, followed by a review of the South African gold-mining industry with notes on production, prices, grades of ore, labour, and details of mining legislation. A chapter giving valuable information and guidance on the mining share markets is included, and those more actively associated with the industry will appreciate the extensive glossary of African and Rhodesian mining terms contained in the following chapter, and also the useful ready-reckoner for rapid calculation of the price of a given quantity of gold. These introductory chapters extend to some 70 pages and the next 800 pages are devoted to detailed descriptions of individual mining companies in alphabetical order. Comprehensive details showing all phases of the activities of some 500 companies are given, such as lists of directors, capital, administrative and technical staff, property, operations, monthly and quarterly returns and accounts, dividends and share prices. The remainder of the book gives information regarding banking and trusts; air, land, and sea transportation in South

Africa and Rhodesia; notes on some of the more important industries associated with mining, and a concluding chapter on the port of Beira in Mozambique.

A similar method of treatment is followed in the companion volume, *Mines of Rhodesia*, in which a number of chapters are repeated, notably the gold ready-reckoner, the mining terms glossary, and the four concluding chapters dealing with transportation, associated industries, and the port of Beira. The list of mines is, as is to be expected, much shorter (although over 120 are detailed), but the book has been enlarged by the addition of chapters on the use of explosives, first aid and malaria control, and the cultivation and preparation for the market of tobacco, tea, and coffee.

The subject matter in both volumes is admirably presented on good-quality paper and the bindings are both attractive and serviceable. The illustrations accompanying the text are good and include several colour photographs in the chapter dealing with the development of the South African railways.

THE GEOLOGY AND MINERAL RESOURCES OF THE NEIGHBOURHOOD OF RAUB, PAHANG, FEDERATED MALAY STATES, WITH AN ACCOUNT OF THE GEOLOGY OF THE RAUB AUSTRALIAN GOLD MINE. By J. A. Richardson, A.R.C.S., B.Sc., F.G.S., Geologist, Geological Survey Department, Federated Malay States. Pp. ix + 166, $10\frac{3}{4} \times 7\frac{1}{4}$. (Singapore: Printers, Ltd., 1939.) Price $3 Straits.

The district of Raub in the western part of Pahang, Federated Malay States, is chiefly known for the existence there of the Raub-Australian gold mine which produces a very large proportion of the total gold output of the Malay peninsula.

In view of the restriction on tin mining which has been in force during the last decade, the desirability arose of investigating the gold resources of the Federated Malay States. Hence a detailed study of the general geology and ore genesis of the principal gold producer of the country was a natural starting point for investigating the possibility of other deposits occurring under similar geological conditions elsewhere.

The present memoir of the Federated Malay States geological survey department is the result of this investigation which was commenced by E. S. Willbourn and concluded by J. A. Richardson.

A considerable proportion of the area studied is covered with dense jungle and outcrops are unfortunately scarcest where the greatest probability exists of there being a continuation of the Raub gold lode. Nevertheless, a very useful geological map (which accompanies the memoir) on the scale of 1 in. to the mile, has been produced.

In the first part of the memoir the author describes in considerable detail the general geology of the district while the second part is devoted principally to the economic geology with particular

reference to the Raub gold lode. The oldest rocks known in the area are shales, limestones and schists believed to be of Permo-Carboniferous age and alluded to as the Calcareous Formation. The overlying Arenaceous Formation, consisting of quartzites, shales, phyllites and chert, is referred provisionally to the Triassic which is the last observed period of sedimentation. Intrusive bodies of serpentine and granite are common, both being post-Triassic and the former being the earlier. Finally tin and gold were introduced from hydrothermal solutions. Cassiterite is found in the Main Range granite in quartz associated with tourmaline, while gold, which was probably deposited later, is found in quartz veins associated with sulphides such as pyrite, stibnite and arsenopyrite. The effect of geological agencies in more recent times has been to promote the accumulation of superficial deposits with isolated placers of gold and tin. Ores of mercury, chrome, nickel and the rare earths have been found but not in payable quantity.

The only important gold mine in Malaya is the Raub Australian Gold Mine which the author describes in great detail with the assistance of numerous line drawings and plates. The property comprises a number of sections some of which were formerly operated as private concerns under different managements and the Raub Australian Gold Mining Company's Concession, granted in 1892 for 50 years covers an area of nearly 20 sq. miles. Negotiations are now proceeding between the company and the Government of Pahang regarding terms for a renewal of the concession. A short but interesting chapter is devoted to a discussion of the future possibilities of the Raub Mine, all aspects of the problem being considered. The author is careful to point out that, while prospects for future lode-mining are encouraging, a large capital expenditure will be required for development. Furthermore, only this type of mining is likely to be remunerative as the discovery of extensive alluvial deposits is unlikely.

TECHNICAL METHODS OF ORE ANALYSIS FOR CHEMISTS AND COLLEGES. By Arthur J. Weinig and William P. Schoder. Based upon the text by Albert H. Low. Eleventh Edition. Pp. x + 325, 9 × 6. (New York : John Wiley & Sons, Inc. ; London : Chapman & Hall, Ltd., 1939.) Price *22s. 6d.*

Twelve years have elapsed since the late Dr. Low's textbook was last revised (see this BULLETIN, 1928, **26**, 269). Progress during these years has necessitated a number of alterations. The new edition omits the introductory section containing general remarks on laboratory procedure and also Chapters 1, 2 and 3 dealing with Apparatus, Electrolysis and Logarithms. Descriptions of some of the less popular methods of procedure have been left out and many of those included have been condensed. The space saved is mainly taken up by an entirely new chapter describing

semi-micro qualitative tests for most of the elements, with a useful series of colour plates illustrating the results of spot-tests. Applications of the qualitative tests for investigating the purity of precipitates and the completeness of precipitation are indicated during the course of the quantitative section. New methods, such as the use of cupferron for the determination of titanium, have been introduced where they have proved more accurate and convenient than older ones.

Each chapter dealing with a particular element is now preceded by a table giving the names, formulæ and properties of its commoner minerals and a list of the usual associated elements.

The revision has been carried out with thoroughness and as a result, Low's *Technical Methods of Ore Analysis* can take a prominent place among the standard books on this subject.

PRINCIPLES OF SEDIMENTATION. By W. H. Twenhofel. x + 610, 9 × 6. (London: McGraw-Hill Publishing Company, Ltd., 1939.) Price 40s.

Students of sedimentary petrology are familiar with the *Treatise on Sedimentation* by W. H. Twenhofel and his collaborators, which has long been regarded as the standard work on this subject. The first edition of the Treatise, published in 1925 and reviewed in this BULLETIN (1927, **25**, 206), was a result of work initiated by the American Committee on Sedimentation which recognised the fact that although there was an extensive literature on sedimentary petrology contained in scientific papers, no comprehensive text-book on the subject was available. The volume, however, was more in the nature of a standard work of reference for the advanced worker than a readable text-book. Indeed, the second edition published in 1932 and reviewed in this BULLETIN (1933, **31**, 317) had grown to over 900 pages and made rather formidable reading for those approaching the subject for the first time.

The present publication, however, departs completely from the method of presentation of the Treatise. It adopts a more logical approach to the subject, by considering the environment in which sediments are produced, transported, deposited and modified. From an understanding of these fundamentals, the student can pass on more readily to a consideration of the actual products of sedimentation. The volume makes a very readable text-book on the subject, whilst for the more advanced student, each chapter concludes with a list of references to the particular aspect of sedimentation with which it deals.

The work is essentially academic in outlook and the genesis of gold, tin, titanium and other economic minerals of sedimentary origin as well as of coal and oil, is given only passing mention.

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Beneficiamento da Apatita em Ipanema, Estado de São Paulo. By J. B. de Araujo. *Avulso No.* 39, *Serv. Fom. Prod. Miner.* Pp. 25, 9 × 6½. (Rio de Janeiro: Avenida Pasteur, 404 Praia Vermelha, 1939.)

Silica Sand

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EXHIBITION GALLERIES, FILM LIBRARIES AND CINEMA

NOTES

Exhibition Galleries.—The Galleries have remained closed to the general public since the outbreak of war, but the exhibits have been made available for inspection by inquirers and by specially conducted parties. The provision of air raid shelter accommodation is now in progress and it is hoped will be completed at an early date, thereby rendering it possible to reopen the Galleries to limited numbers of the general public and to conducted school parties.

Assistance has been given in the reopening of certain of the galleries in the Natural History Museum by the loan of specimens of economic products for making temporary displays of topical interest.

Hitherto the exhibits shown in the Indian Court have consisted chiefly of vegetable and mineral products, there being a difficulty, owing to the nature of the material, in displaying products of animal origin. In view, however, of the importance of the animal industry in India, a representation of the industry in some attractive form that would appeal to the ordinary visitor has for some time past been considered desirable. Mr. F. Ware, C.B.E., F.R.C.V.S., I.V.S., the Animal Husbandry Expert on the Imperial Council of Agricultural Research, India, supported this view on the occasion of a recent visit to the Galleries, and it was accordingly decided to include in the Indian Court a representation of some phase of the animal industry such as improved cattle-breeds, dairying, or tanning. The acquisition through Mr. P. T. Kerr, M.R.C.V.S., I.V.S., of some excellent photographs of the second All-India Cattle Show which was held in New Delhi in February 1939, together with a number of scaled photographs of various types of improved Indian breeds, suggested a scheme for a new type of exhibit which, after careful study, has since been successfully carried out in the Imperial Institute Studio by Mr. A. J. Carter. This consists of accurately coloured, scale models of different breeds of animals arranged in their show pens at the All-India Cattle Show with attendants and their tents and show equipment. Although only a small section of the show has actually been modelled, an ingenious arrangement of

mirrors at both ends of the show case, specially constructed in the Imperial Institute workshops, reflects a long row of tents and animals, this giving the impression which a visitor to the show would receive. The second All-India Cattle Show has thus been utilised to represent the animal industry of India in the Indian Court. The number of animals shown is limited to twelve at present representing nine different types, but it is hoped to add more as and when funds become available.

The following animals, one-sixteenth actual size, are shown in the model: Bhagnari bullock—Baluchistan and Sind; Dhanni bull—Punjab and North-West Frontier Province; Gir bull—Kathiawar and Western Rajputana; Kangayam bull—Madras; Kankrej cow and bull—Kutch, Sind and Bombay; Nimari bull—Central India; Sahiwal bull and heifer—Punjab; Khalsa buffalo cow—North-West Frontier Province; Murrah buffalo bull and cow with calf—Punjab and Delhi.

The success attending the erection in the Burma Court of a section of the teak façade and ornamental eave-boards of the Burma Pavilion, Empire Exhibition, Glasgow, has led to a further addition of a portion of the eave-board and a finial above the Yinma panelling and doorway. The graduated flamboyant spires which are chiefly responsible for a boldness in design and lightness in style of Burmese architectural carving are greatly in evidence, and lend a local atmosphere to the Court. So far as the representation of the uses of wood on traditional lines is concerned the display in the forestry section can now be considered complete. It now only remains to add examples of the modern applications of Burma woods and it is hoped that additional exhibits to this end will be made available in the near future.

Tea, rubber, coconut, spices and plumbago are Ceylon's most important economic assets and these products are accordingly fully represented in the Ceylon Court. Ceylon, however, also possesses arts and crafts which, small as they may appear when compared with her great industries, nevertheless constitute a living force among her people, which has been in evidence from very early times to the present day. It is, therefore, fitting that in addition to the existing centre case displaying selected types of local handicrafts, a wall case should be specially set aside for a comprehensive display of cottage industries, including metalware, pottery, woodwork, and fancy articles in ivory, horn and tortoiseshell, lacquerwork, textiles, rattan and bamboo work. This has been done, and a display rendered possible through the good offices of the Ceylon Trade Commissioner in London who has kindly agreed to transfer a representative exhibit of the island's cottage industries from his office to the Court.

To the St. Helena Court has been added a selection of enlarged mounted photographs of scenes in the island taken by Mr. W. A. Fortens, A.R.P.S., Official Photographer to the Peninsula and

Oriental Steam Navigation Company. These enlargements are arranged to form a travelogue, whilst from three of his negatives transparencies for the window of the Court have been prepared.

A series of photographs of scenes in Ovamboland has been made from negatives placed at our disposal by South Africa House. These are now displayed as a travelogue in the South-West Africa section of the Union Court.

To the South African manganese exhibit have been added specimens of ferro-manganese, refined ferro-manganese, metallic manganese, manganese-copper, manganese-aluminium and manganese-boron kindly donated by Messrs. Blackwells Metallurgical Works, Ltd.; also photographs derived from several sources to illustrate some of the more important uses of manganese alloys.

Through the generosity of Mr. G. A. LaBine, President of the Eldorado Mines, Ltd., of Toronto, a series of interesting photographs of the winning of radium ores in the Great Bear Lake region of the North-West Territories has been acquired for the Canadian Court. The photographs show (i) an aerial view of the area and part of LaBine Point, (ii) a general view of the mine, (iii) trestle from mine adit to the mill, (iv) sorting high grade ore, and (v) tabling radium-bearing concentrates. From the same donor have been received three specimens of pitchblende and a sample of jig concentrates, and these are displayed in association with the photographs in a show-case in the Canadian Court. To add a human interest to the display a loan exhibit has been acquired from Messrs. Johnson Matthey & Co., Ltd., of London, showing some of the applications of radium in the service of health.

In the New Zealand Court an experiment has been made in exploiting the background of a showcase with a view to achieving a unity of showcase and contents in a realistic way. New Zealand's fruit industry has been chosen for this experiment. Hitherto the industry has been represented in the Court by a series of enlarged photographs and groups of modelled apples displayed on flat glass dishes. Now, the back and sides of the interior of a wall showcase have been converted, by a combination of carpentry and scenic painting, into the interior of a bay of a bungalow on a New Zealand fruit farm giving a view, through open central french doors and side windows, of extensive orchards with pastoral country beyond. Trees laden with ripe fruit close to the windows serve to link up in scale the painted fruit in the orchard with realistically modelled apples in baskets occupying the floor of the bungalow, which is actually the floor of the showcase. The apples represented are of the varieties usually exported to this country, and the caption for the whole exhibit reads: "New Zealand's wealth spells England's health: New Zealand's health-giving apples are exported mainly to the United Kingdom."

This innovation having proved satisfactory, the artist responsible for the scenic work, Mr. Montague Black, is now engaged upon two

other scenic backgrounds for the New Zealand Court, one for the dairy exhibit and the other for the meat and wool exhibit.

A number of additional window transparencies have been inserted almost completing the circuit of the Australian Court. In this Court also, so far as existing material will allow, progress has been made with the rearrangement of the exhibits to tell the stories of miscellaneous food grains, meat and its by-products, and hides and skins.

Photographs have been received through the Malay Agent in London illustrating modern methods in the pineapple and oil-palm industries, which have enabled these exhibits in the British Malaya Court to be brought up to date. Together with these photographs have been received a set illustrating rice irrigation works, and others which have been used in a pictorial travelogue illustrating the important places visited in a tour down the western side of the peninsula. Starting at the island of Penang with Georgetown, other places depicted in sequence in the travelogue are the Residency and Gardens, Taiping ; Kuala Kangsar with its Mosque and Palace ; The Town Hall at Ipoh ; Kuala Lumpur with the Federal Government Offices ; Seremban Town and Lake ; the Palace at Sri Menanti ; the port of Malacca ; a number of views of Johore Bahru, its administrative buildings and the causeway uniting the town with Singapore and finally a view of the town and harbour of Singapore. An accompanying map marked with numbers in red serves to locate the towns depicted.

Picture Postcards.—Three new sets of picture postcards have been prepared and issued as additions to the Imperial Institute Series of Photographic Picture Cards illustrating Empire Industries. These new additions bring the series so far published up to a total of thirty-two sets, each set consisting of six photographic cards illustrating in sequence the story of the industry and including a descriptive leaflet with an area map. These are sold at 6*d*. per set and are primarily intended for school use with the epidiascope.

One of the three new additions deals with wool in Australia and the other two treat of lumbering in Canada. The leaflet for the wool series reads as follows :

The Wool Industry of Australia

" From very small beginnings Australia has to-day reached a position of world pre-eminence in the production of wool. The sheep is not native to Australia. A few sheep bearing fine merino wool were introduced into New South Wales towards the end of the eighteenth century, and these and later arrivals in Australia provided the foundation for the enormous number of fine quality wool-producing sheep that exists there to-day.

" Australian wool comes very largely to this country. Other

important purchasers of Australian wool in normal times are Japan, France and Belgium.

"Wool is one of the most important of clothing materials, especially in cold and temperate climates. The wool fibre is elastic and is distinguished by having fine serrations, rather like the scales of a fir cone, on its surface. This peculiarity of wool enables the individual fibres to be spun easily and to felt together better than either cotton or silk.

"The imported wool on arrival is first scoured free from grease and soil and then passed on to the carding machine which arranges the fibres of the wool roughly parallel to one another. It is afterwards combed, drawn out and twisted; spun into yarn; and finally woven on looms into worsted fabrics and fine woollens. Shorter fibres which are eliminated in the combing machine are used in making blankets and felting for hats.

"1. *Australian Merino Sheep.* The well-bred merino sheep of Australia with their splendid fleeces yield over one-half of the world's production of fine quality merino wool. Wool of less fine quality is produced by sheep derived from merino ewes mated with rams of English breeds. These cross-breds (as they are called) serve also the needs of the meat industry.

"2. *Mustering Sheep for Shearing.* Australia has a larger number of sheep than any other country and produces about 27 per cent. of the world's wool. The flocks range in size from under 500 to over 100,000 head. Nearly one-half of the total is raised in New South Wales but all the states possess large numbers of sheep.

"3. *Shearing the Sheep.* The shearing is done by machinery in a wool shed. It takes an expert only about three minutes to shear one sheep. After being sheared the sheep is released through a small opening or doorway which leads into the particular shearer's counting-out pen.

"4. *Trimming the Fleece.* After the shearing, the belly wool is separated and the fleece is thrown to the skirting or rolling table where the neck, the coarse and the stained parts are removed. The trimmed fleece is then rolled and passed to the wool classer who classes it for spinning quality, colour and condition.

"5. *Transporting Wool Bales.* The trimmed and graded fleeces are pressed into wool packs of about fifty fleeces each. These packs are transported from the sheep station by horse or bullock team, or by motor lorry, to the railway or direct to a wool selling centre.

"6. *An Australian Wool Store.* At the wool store the bales, branded with the owner's initials, the name of the sheep station, and the description of the wool, are weighed and then opened up for the inspection of buyers. After purchase each fleece is divided by wool sorters into parts according to quality. The manufacturer may thus obtain the particular type he requires to enable him to spin an even, regular thread of yarn."

The leaflets for the two Canadian lumbering sets are as follows:

The Forests of Canada

"Forests cover one-third of Canada's total land area and are one of her chief sources of wealth. They provide employment in logging and lumbering; raw material for pulp and paper manufacture, and for a number of wood-using and paper-using industries.

These industries in the aggregate amount to between 20 per cent. and 30 per cent. of the total manufacturing industries of the Dominion, and rank second only to agriculture in the value of the export goods they produce.

I. The Eastern Forests

" Eastern Canada was the cradle of the Canadian lumbering industry, but the territory is now primarily a pulpwood area, although large quantities of timber are still obtained. Some of the largest pulp and paper mills in the world are found in this region, which is characterised by interlacing systems of lakes and rivers. These waterways, coupled with rigorous winters followed by sudden spring thaws, are factors which determine the logging and lumbering methods practised.

" 1. *A Mixed Forest in Eastern Canada.* This air-view shows spruce, pine and fir intermingled with birch, maple, elm, poplar and basswood. Note the general flatness of the country and the network of rivers and lakes which are used for floating logs from the forests to the mills.

" 2. *Unloading Logs into the River.* The trees are felled during the winter when the forest floor is frozen and snow-bound. The logs can then be ' snaked ' and sleighed out of the woods with a minimum of effort. They are piled on the ice or the sloping banks of a stream to await the spring thaw.

" 3. *The Start of a Log Drive.* When the melting ice and snow provide the annual ' freshets,' the piles of logs are rolled into the stream. They are carried by the fast flowing current down to the mills, being guided on their way by intrepid river-men.

" 4. *Blowing up a Log Jam.* Log jams frequently occur where a river bends suddenly or becomes shallow over an uneven bed. These ' jams ' are usually broken up by the river-men armed with pike-poles or peavies, but when these efforts fail dynamite is used.

" 5. *Log Boom at the Mills.* After an eventful journey of 100 or more miles, the logs are collected in a boom at the mills to await conversion into lumber, or into wood-pulp and paper.

" 6. *Pulp and Paper Mill, Quebec.* At mills such as this the logs are converted by grinding or chemical treatment into wood pulp for paper-making. The principal kind of paper made is newsprint.

" Note the huge log pile at the left of the picture."

II. The Western Forests

" The forests of Western Canada are almost entirely in British Columbia. Here, a long growing season accompanied by abundant rainfall and little frost, has produced some of the heaviest stands of timber and some of the largest trees to be found anywhere in the world. Composed very largely of conifers, such as Douglas fir, western hemlock, western red cedar, sitka spruce, western white pine and western larch, these forests are among the last to be exploited and they produce more than half of Canada's output of lumber. Owing to the mountainous nature of the country and the lack of rivers and streams, logging railways are used in place of the

water transport found in Eastern Canada, while the larger trees and much heavier logs necessitate elaborate mechanical systems for their handling and transport.

"1. *In a British Columbian Forest.* This picture gives a good idea of the density of growth and the height and large sizes of the trees which have to be felled and handled.

"2. *Felling: Cutting the Kerf.* The direction of tree fall is carefully predetermined by cutting a deep wedge-shaped groove on the side facing the direction of the required fall. The groove provides a kind of hinge.

"3. *Felling: Using the cross-cut Saw.* The tree is sawn through from the side opposite to the kerf, steel wedges being driven in as the cutting proceeds in order to keep the sawcut open. At the first signs of 'give,' the sawyers jump clear to avoid the 'kick' of the stump end of the falling tree. The felled tree is then stripped of its branches, and sawn ('bucked') into logs of convenient length.

"4. *Hauling and Loading Logs.* The 'high-lead' system of logging is extensively practised. Suitable spar trees are chosen at intervals of some 600 yards along and adjacent to the logging railway and these are used as central points around which felling is conducted. They serve also as masts to which tackle is fixed for hauling ('skidding') and loading the logs. A donkey engine is employed for working the tackle and for lifting the logs on to the railway trucks.

"5. *A Train of Logs arriving at Tidewater.* On arrival at the sea terminus of the logging railway, the train is backed along a jetty and the logs are mechanically unloaded direct into the water. They are then formed into huge rafts ('booms') which are towed along the coast by steam tugs, possibly 100 miles to the saw mills.

"6. *A Typical Saw Mill in British Columbia.* These saw mills are among the most modern in the world and are fitted with every mechanical device for handling the largest logs and for cutting and shaping them into every imaginable form of commercial timber, the chief products being dimension lumber, constructional timbers, shingles, posts, poles, piling, railway sleepers, etc., both for use in Canada and for export throughout the world."

Empire and G.P.O. Film Libraries.—Since the issue in September last of the 1939 Catalogue of the Empire Film Library, 92 new prints have been added to the stock of films available for distribution in the United Kingdom. Of these, 49 cover 18 new subjects, the remainder being additional prints of subjects already indicated in the Catalogue.

The new subjects include the following films which were transferred to the Library by Imperial Airways at the commencement of the war—"The Future is in the Air," "Air Outpost" and "Air Background." Of the remainder, 7 relate to the United Kingdom, 1 to the Channel Islands, 1 to Canada, 3 to India, 2 to British East Africa, and 1 to the West Indies.

The United Kingdom films deal with "Protection of Fruit" showing how spraying to a large extent counteracts the damage caused by insect pests and diseases in orchards; "Water Power," illustrating modern methods of utilising power to generate elecricity; "Home Produce for the Nation," dealing with the purposes of the National Mark Schemes and the produce covered by them;

"Cheese for Choice," the processes determining eight varieties of National Mark cheese made in England; "This Egg Business"; "Plums that Please"; and "Honey Bees."

The Channel Islands film deals in a general way with the Island of Jersey and contains excellent colour shots of the Battle of Flowers.

The latest Canadian film is entitled "Behind the Headlines" and describes the production of a newspaper in the Dominion, whilst welcome additions relating to India are "Mica Industry," "Glimpses of the East" and "Eastern Architecture," the last-named containing fine views of the Taj Mahal.

"The People of Uganda: their Life and Industries" and "King of Beasts" are new subjects relating to British East Africa and a travel film entitled "British Guiana" deals with the scenery, types of people and industries of that Colony.

In addition, 24 prints of 5 new subjects and 34 prints of subjects already in the Library have been added to the G.P.O. Section.

Colonial Visitors.—The following is a list of officers on leave from the Colonies, etc., who have visited the Institute during the three months November and December 1939, and January 1940.

NOVEMBER

E. F. PECK, Chief Veterinary and Agricultural Officer, British Somaliland.
J. W. PURSEGLOVE, Agricultural Department, Uganda.
F. A. SQUIRE, Entomologist, Agricultural Department, Sierra Leone.
H. J. R. WAY, Geologist, Geological Survey Department, Uganda.

DECEMBER

D. W. BISHOPP, Economic Geologist, British Guiana.
J. E. A. CARVER, Conservator of Forests, Mauritius.

JANUARY

D. W. H. BAKER, Agricultural Officer, Nigeria.
L. BINTLEY, lately Government Architect, Zanzibar.
A. FOGGIE, Assistant Conservator of Forests, Gold Coast.
Dr. M. H. FRENCH, Bio-Chemist, Veterinary Department, Tanganyika Territory.
Dr. W. RUSS, lately Geologist, Nigeria.
D. THORNTON, Agricultural Officer, Tanganyika Territory.

All Dominion and Colonial Officers, as well as private residents overseas, who may be visiting London, are cordially invited to come to the Institute to see our Exhibition Galleries and to discuss scientific and technical problems in which they may be interested.

The Story of the British Colonial Empire.—Under this title the Colonial Empire Marketing Board have issued an excellent account of the various Colonies and Dependencies, with special emphasis on their products—the foods and raw materials which are so needed in the home market. It is written by Douglas Woodruff, has over 175 illustrations by Ralph Mott and nine colour plates by Lauder, contains 151 pages and is published at a price that brings it within

reach of all (*2s. 6d.*, by post *3s.*). It is published by H.M. Stationery Office and can be obtained through any booksellers or from the Imperial Institute, London, S.W.7.

The book will be found exceedingly easy to read. It brings to life and significance the whole remarkable present-day story of the distant islands, the tropical and sub-tropical colonies, protectorates and other dependencies which make up Britain's Colonial Empire.

It is a study in interdependence, an unfolding, in its largest outlines, of one of the greatest, and, on the whole, most hopeful enterprises of the twentieth century, the economic and consequent social development of vast unworked territories under the leadership of Great Britain.

The story it has to tell is not primarily a record of past historical events but an unfolding of living realities. It describes how the activities and prospects of the remote and often primitive peoples of the Colonial Empire are being moulded and determined by the habits and preferences of the population of Great Britain. This study of historical interplay, of present activities and future prospects, has been written to fill a gap only too common in the general knowledge of the otherwise well-informed. It aims to replace names which are but names by clear ideas of the places and things for which those names stand, and to deepen interest in, and understanding of, remote places with big futures, for which the British electorate has the ultimate responsibility to-day.

BULLETIN
OF THE IMPERIAL INSTITUTE

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EMPIRE SERVICES OF THE IMPERIAL INSTITUTE IN WAR-TIME

By SIR HARRY LINDSAY, K.C.I.E., C.B.E.,
Director of the Imperial Institute

(Condensed from an address given before The Royal Society of Arts, April 2, 1940.)

THE fairly wide responsibilities imposed by the Imperial Institute Act of 1925 fall under two major heads[1]; our technical and scientific work directed chiefly to the encouragement of the production, uses and marketing of the raw material resources of the Empire. Secondly there is our educational work which at first centred chiefly on our Galleries, lectures and exhibitions of economic products, and has since, with the progress of science, incorporated other branches of visual instruction in the Empire such as films, lantern-slides, picture-postcards and school specimens.

Let me take the scientific and technical side first. We have a staff of about forty scientists, some of whom work in our laboratories, others in our intelligence and statistical offices and library. We receive technical inquiries from all over the Empire, from the technical departments of the Governments or from producers or exporters overseas as well as from importers and manufacturers of the United Kingdom. Our laboratories are equipped[2] to enable us to deal with specimens and samples of raw materials from any part of the Empire, animal, vegetable or mineral; to investigate them; and to report upon them. We also answer innumerable trade and marketing inquiries. The results, if considered sufficiently important, are published in our quarterly BULLETIN, and we also from time to time publish monographs on economic products. I don't

[1]Particulars of the origin and functions of the Imperial Institute will be found in this BULLETIN, 1939, **37**, 517-520.

[2]See Appendix.

think it is any exaggeration to say that, during the fifty odd years of the existence of the Institute, there are very few raw materials indeed which have not at one time or another passed through our hands ; and on which we are not able to give up-to-date information with the help of the scientific journals, in a wide range of languages, which we index.

To help us on the scientific and technical side of our work we have the great benefit of the experience and advice of two Councils, one on Plant and Animal Products and one on Mineral Resources. In addition, fifteen Consultative Committees are responsible to the two Councils, the subjects dealt with by each Committee falling under one or other of the main classes of raw materials such as Timber, Hides and Skins, Vegetable Fibres, Oilseeds and Oils, Precious Metals, Base Metals, Iron and Steel and Ferro-Alloys, Coal and Petroleum, and so on. The Chairmen of the two Advisory Councils are, respectively, Sir Frank Stockdale for Plant and Animal Products, and Sir William Larke for Mineral Resources. Both names are, I am sure, well known to my audience. The members of the Councils and Committees are eminent scientists, business men or administrators ; and I am very glad of this opportunity to bear public witness to the great value of their co-operation in helping us to deal with the many technical and marketing inquiries which we receive from all quarters of the Empire.

Now let me turn from our scientific and technical work to our responsibilities for visual instruction in the life, scenery and industries of the Empire. We have four Exhibition Galleries which lie behind the Institute in a great rectangle and run east and west and south and north ; their total aggregate length is roughly one-third of a mile. Each Gallery is divided into Empire Courts so arranged that the various countries represented follow each other in geographical sequence. Each Court tells, by means of dioramas, photographs, models and specimens, the story of the Empire country represented, its chief industries, its scenery and the life of the people. Our guide lecturers conduct parties of visitors round the Galleries and explain the exhibits in the various Courts. Our Cinema shows regular programmes of Empire films and our Empire Film Library circulates such films to schools and societies throughout the length and breadth of the United Kingdom. With the Empire Film Library we administer, as agents for the Postmaster-General, the G.P.O. Film Library. The combined circulation of both libraries has increased during the past five years from 17,500 to 37,000 bookings, and the number of organisations which borrow films from us has increased during the same period from 1,900 to 3,500.

To complete this story of our activities in the domain of visual instruction in Empire subjects, let me add that we have recently taken over, by courtesy of the Victoria League and of the Royal Empire Society, a very fine collection of some 10,000 lantern slides of the Overseas Empire. These are arranged in collections of 50

slides and are in some cases accompanied by lecture-notes. The slides, like our films, are lent freely and widely to school teachers and societies throughout the United Kingdom at no charge save that we recover the transport costs. This is a great national service, the value of which is highly appreciated by the educational authorities of this country.

With the outbreak of war and the evacuation of school children from the London area, we at once closed our Exhibition Galleries and Cinema. In response to public demand, however, we reopened our Exhibition Galleries and Cinema on Easter Saturday, Sunday and Monday, and every Saturday and Sunday afternoon since.

The biggest change which has occurred under war conditions has been the transition from school party to adult audiences. I don't mean to say that the actual exhibits have been changed. But the technique of interesting children in those exhibits is quite different from that of interesting adults.

For the vital factor in visual instruction is interest—interest in the sense of a readiness and a capacity to turn your mind outwards towards natural facts in the natural world just because they are natural and not merely because they happen to strike some whim or fancy of the spectator. A schoolboy once remarked that "when a man is wrapped up in himself he makes a very small parcel"; and no truer word has ever been uttered—particularly in its application to education.

I now turn to the other half of our visual instruction work, our Empire Film Library and collection of Empire lantern slides. Here the transition from child-education to adult-education is not so marked—indeed there has been little if any change on this score. The total number of borrowers on our registers is about 3,500 schools and societies, with the schools definitely preponderating. The number of bookings of our films last year was 24,000 and of the G.P.O. films, for whose circulation we act as agents of the Postmaster-General, 13,000, giving a combined total of 37,000; the aggregate total number of persons who saw the films probably exceeded seven million.

On the outbreak of war, practically all bookings of our films were suspended as a result of the evacuation of schools, and this service remained in abeyance during September and October. From November onwards the demands for Empire and G.P.O. films began to revive and we are now as busy as we were before the war. But we have noticed several changes.

Firstly, transport is not quite so quick as it was. We must allow three days for dispatch and return, plus one day for showing, or four days in all, against three days pre-war, i.e. two days' transport and one for showing.

Secondly, schools in reception areas are beginning to submit co-operative demands for films, involving two or three days' displays or even longer to different schools in the same area, or to different classes of the same school.

Thirdly, there have been considerable changes in our borrowers. Some schools have dropped out altogether and others—new borrowers—have taken their places. There has undoubtedly been a tendency for town schools invading country districts to make country schools more film conscious and it is hoped that this effect will remain after the town schools return; and teachers tell us that over half of the film material which has been available in the reception areas has come from the Empire and G.P.O. Film Libraries.

I do not propose to give a detailed account of our Empire lantern-slide collections, which as I said we have only recently acquired. It is enough to point out that they are popular with school teachers and that the effect of the war has been, if anything, to stimulate the demands for the loan of these aids to visual instruction.

I now turn to give some account of the scientific and technical activities of the Imperial Institute during war-time, with this proviso, that I am not, of course, at liberty to divulge anything of a confidential character. I will, however, say just this by way of preface, that one of our statutory responsibilities is to advise on the development of the animal, vegetable and mineral resources of the Empire in order that such resources may be made available for the purposes of Imperial defence.

Preparatory work of the Imperial Institute began many months before the outbreak of war when a number of exhaustive reports were compiled by the intelligence staff of the Mineral Resources Department. They dealt with the mineral industries and resources of a number of countries and proved later to be of great value to the Intelligence Department of the Ministry of Economic Warfare.

Upon the outbreak of war part of the Imperial Institute staff, consisting of the Principal of the Mineral Resources Department of the Institute and fourteen scientific officers together with a number of statisticians, technical indexers and clerical officers, was lent as a complete unit to the Ministry, constituting almost the whole personnel of their Commodities Intelligence Section. The Ministry was thus equipped at once with a trained staff able to deal with technical and trade matters of a very varied character. The work they carried out consisted mainly in advising the various sections of the Ministry on matters of a technical nature. The trade contacts which the Institute staff had made prior to the war (including many persons who had served on Imperial Institute Consultative Committees) proved of great value as they often enabled the Ministry to obtain information which would not otherwise have been so readily available; for example, regarding the operations of firms which might reasonably be considered as likely to help the enemy. Of special importance was the work done in connection with the protracted and difficult negotiations carried on with the representatives of several of the neutral countries adjacent to the enemy with a view to drawing up war trade agreements. Several members

of the staff were present during many of the meetings with these foreign delegates and assisted the negotiators with advice on the many difficult and delicate problems which arose.

Other matters with which the staff were concerned included the interpretation of items on ships' manifests, the collection of data concerning suspect firms and individuals, the preparation of reports on the location, capacity and nature of plant for producing a number of vital war commodities in various foreign countries, and of reports on the nature and potential and actual uses of many raw and manufactured products. Of particular value was the work done by the small group of Institute statistical officers. Some idea of the volume of work handled may be gathered from the fact that during the first six months of the war over 5,000 inquiries were handled exclusive of numerous personal discussions. In a communication to the Imperial Institute the Ministry described the Commodities Intelligence Section as one of the most efficient of the technical sections of the Ministry and quite indispensable.

Although our team of experts returned to us after six months' work with the Ministry of Economic Warfare, our contact with the Ministry remains close, for we have appointed one scientific officer, at the Ministry's request, to act as liaison officer between their organisation and ours. We have also seconded two of our scientific officers, one from the Plant and Animal Products Department and one from the Mineral Resources Department, for duty with the Ministry of Supply.

It is interesting to note that food values are playing an important part in the work we do in regard to plant and animal products. After all, food values provide the home-front energy, if minerals provide the explosive forces of the firing-line. And food values have attained an added importance in the light of the new policy recently announced by the Right Hon'ble Malcolm MacDonald for the development of the health and social welfare of the Colonial Empire.

Another service which we perform at the Imperial Institute relates to the development of the natural resources of the United Kingdom, where such development is economically sound and minimises the necessity for imports with their inconvenient demands both on freight-space in fully-loaded homeward-bound ships and on foreign exchange. The Government of this country has recently announced its determination, firstly, to stimulate the production of home-grown flax and secondly to encourage the production of non-ferrous metallic ores in the United Kingdom. The Imperial Institute was consulted on both these projects and gave such advice as was possible in connection with them ; and it is not unlikely that we shall be consulted further from time to time as progress is made with both schemes. The Chairman of the Committee on non-ferrous metallic ores is Sir William Larke, the Chairman of our Advisory Council on Mineral Resources.

The assistance which we are qualified to give to the United Kingdom manufacturer and exporter is complementary to that afforded by the Department of Overseas Trade. In the White Paper (Cmd. 6183) in which the President of the Board of Trade described the aims and plan of work of the recently created Export Council, the following sentence occurs: "It is clear that each industry in considering export development has problems of raw materials, prices, distribution and markets, which are highly specialised." Now it is exactly in the first of these four spheres, namely, raw materials, that the Imperial Institute, with its laboratories and its indexed technical information about natural products, their sources, utilisation, qualities, quantities, etc., is best able to help the United Kingdom manufacturer and thus to supplement the work of the Department of Overseas Trade. Looking through our records of December and January last, I find that we have been able to help manufacturers for export in regard to many of the raw materials they require, sometimes in quite interesting new developments. I quote the following at random: new Empire sources of fibre and of paper pulp; the food values of cotton-seed meal; comparative starch values of different products and the machinery required for its extraction; sources of carob beans and edible nuts; the raw materials for paper, fibre board, veneer and plywood manufacture; the uses of piassava fibre; Empire sources of fire-resisting timbers; Empire supplies of tung oil; flints for automatic lighters; Empire sources of ground mica; United Kingdom sources of bauxite, barytes and diatomite; bentonite for the manufacture of insecticides; uses of peat; and so on. It is, of course, at the raw material end that the manufacturer's difficulties only begin, especially under war conditions, and here we are equipped and competent to help him.

I have said something about the technical services we render to Empire Governments and to merchants and manufacturers of the United Kingdom. In conclusion, I should like to draw special attention to our work in the interests of the primary producers of the Overseas Empire. It is very generally agreed that, ever since the trade boom of 1919-20 which followed the Great War, and the trade-slump of 1920-21 which succeeded it, the primary producer all the world over has had a very poor time.

Now the economic position of the primary producer of the British Empire has always been a matter of first importance to the Imperial Institute. From a consideration of the objects for which we were founded and of the way we are equipped to carry out those objects, it is obvious that any action which we can take to stimulate the development of the raw material resources of the Empire, and particularly to discover new uses and new markets for them, is all to the benefit of the primary producer whether he be agriculturist, fisherman, lumberjack, mineowner or pastoralist. And in time of war he is particularly in need of our help.

It is true that some of the large-scale industries, efficiently organised, such as tea, rubber, sugar, tin and copper, have been able to take control, to set their own houses in order, and to approximate supplies to demands. But most primary producers in the Empire are quite incapable of united action of this kind. They can count neither on the steady demands nor on the improving prices which control does tend to give. They are at the mercy of markets often remote and usually incomprehensible.

In these circumstances they have come to rely on the Imperial Institute for services which only a central institution such as ours can give. As I have already shown, we can help with scientific and technical information both about their products and about market practice. We can translate into their own language the criticisms offered to them by importers, brokers and merchants in distant markets, which criticisms, though friendlily meant, are too often couched in terms not easily understood. We can temper destructive criticism with the kind of assistance and advice which the overseas producers really need if they are to meet the competition of foreign goods which may happen to have become popular.

For the one remedy for a state of affairs in which the primary producer is too often tempted to despair is Science. Whether it be the Science of Production or the Science of Distribution, scientific method is necessary for any real improvement, and it is no less necessary in time of war than in time of peace—perhaps even more necessary. One hopeful sign for the future is the tendency on the part of the Allied Governments to purchase whole crops at a time—for example, the agreement to buy some Empire wool-clips as they come forward, for the duration of the war and for one season thereafter; or the purchase of Empire tea—cocoa—and sisal crops. That is the sort of practice which, let us hope, has come to stay. It assures to the primary producer not only an agreed price, but also a certain market for his goods. It is, in fact, an application of scientific method to the practice and procedure of war-time economics.

That concludes my account of Empire Services of the Imperial Institute in war-time. These services are widespread throughout the Empire, as I am sure you will agree, for they extend to every Government of the Empire, Home and Overseas, as well as to producers, merchants and manufacturers. They include not only the science of technical information to promote the development of the resources of the Empire in raw materials; but also the art of visual instruction in the life, scenery and industries of the Overseas Empire. A combination of Art with Science—that is a not inaccurate summary of our general terms of reference—the capacity to give sound technical advice to business men who need it whether at home or overseas, and the capacity to present scientific facts about the Overseas Empire artistically, to meet the educational needs of the general public of the United Kingdom, whether adult

or juvenile. This is the double task which was imposed upon the Imperial Institute at its foundation and which we try to carry out faithfully, to the best of our ability, in war-time no less than in times of peace.

APPENDIX

The Laboratories of the Imperial Institute

The scientific and technical departments of the Institute are provided with extensive modern laboratories and workshops equipped with the additional specialised plant and apparatus necessitated by the character of our work; and it is our aim to keep them thoroughly up to date. It is not possible to give an exhaustive list of their activities and potentialities, but the more important aspects of the work are included in those mentioned below. These are frequently inter-dependent, and a sample must often be examined from several points of view before a complete report on its possibilities can be furnished.

In the Plant and Animal Products Department the main chemical laboratories are arranged for the analysis and general examination of all classes of plant and animal commodities; foodstuffs, oils, oil-seeds, pulp and paper-making materials, gums, resins, tanning materials, dyestuffs, essential oils, insecticides, tobacco, drugs, and so on. For the examination of cotton and other fibres we have optical and other equipment, including apparatus for strength tests of long fibres and twines. For testing the strength of ropes there is a special machine on which our work on the relative durability of sisal, manila and on phormium ropes after periods of immersion in the sea was carried out. We have done much work on essential oils, and for distilling these from the plant materials concerned we have modern stills erected in the workshops. For dealing with the non-volatile edible and other oils from seeds and nuts, e.g. coconut oil, sesame and tung oils, it is necessary to have nut cracking and decorticating machines and a laboratory oil press. And, of course, there are coffee hullers, tobacco cutters, and so on, as required for the various commodities examined.

Our equipment for pulp and paper-making trials is of special interest. This is of the most modern type and includes digesters in which the test material is " cooked " with chemicals to yield the pulp, which is " beaten " in a special ball mill. The resulting material is converted into paper in a standard sheet machine. The standard sheets obtained must be tested for strength and other qualities under uniform conditions, and the staff have recently designed and erected a " constant humidity and temperature room " of the latest type in which these tests are carried out by special machines. We thus have all the means necessary to prepare and test finished papers from wood, logs, bamboos, grasses and other paper-making materials; it is one of the most up-to-date experimental testing plants in this country outside the paper mills.

In the two chemical laboratories of the Mineral Resources Department, analyses can be made of any mineral substance which may be received. These analyses are often of considerable difficulty, but the staff keep in touch with recent developments in technique, and new methods, such as those of micro-analysis, are often used when necessary. Apart from the analyses of minerals and ores, other products, such as fertilisers, solid and liquid fuels, potable and mineral waters, etc., can be examined. In Nyasaland, for example, the water supplies of the Colony are being investigated by the Geological Survey Department, and a large number of waters have been analysed at the Institute to determine their suitability for use. The Department is also equipped for the assay of ores containing gold, silver, platinum, etc.

A special laboratory is well equipped for ceramic work, and practical small-scale trials can be made to determine whether clays are suitable for making bricks and tiles, porcelain, stoneware, china, earthenware, or refractory products. The apparatus available includes a clay-washing plant, brick or tile press, auger machine, potter's wheel, etc., with the furnaces necessary for firing the test pieces at the appropriate temperatures. These include a high-temperature furnace capable of reaching a temperature of 1750° C.

Another laboratory is fitted for testing raw materials to determine their suitability for use in making natural or Portland cement, hydraulic lime, natural or artificial pozzolana, etc. Portland cement can be made on a small scale in a specially designed furnace, and the product tested according to standard specification requirements. Manufactured cement can, if required, be tested in accordance with British or other specifications.

Mineralogical investigations are of considerable importance and frequently go hand-in-hand with the chemical work. The Department is equipped for the complete mineralogical examination, by microscopic and other physical means, of rocks, minerals, ores and concentrates of all types. From a consideration of the results obtained in this work, it is frequently possible to offer opinions regarding the commercial value of a mineral product, or to give advice on methods of preparation for the market.

Finally, chemical and mechanical analyses can be made of soils, and information thereby afforded from which it is possible for suggestions to be made regarding the plant-food constituents which should be added in the form of fertilisers, or the type of crop for which the soil may or may not be suitable.

PLANT AND ANIMAL PRODUCTS

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Indian and Colonial Governments

PLANT INSECTICIDE MATERIALS FROM EMPIRE SOURCES

DURING the past two decades there has been a strikingly rapid increase in the use of insecticide materials derived from plants, and in many fields they are replacing the chemical insecticides formerly used. This growth is largely the outcome of scientific work not only on the applications of plant insecticides but also on their production, through establishing the crops in new countries, improving the quality of types already known and the discovery and testing of new ones.

The work of the Imperial Institute in this field has included the examination of a number of samples of different insecticidal plants and the formation in 1937 of a Consultative Committee, with representatives of Colonial and trade interests, to consider questions likely to assist in the development and marketing of these products from Empire sources. Under the auspices of this Committee the preparation was undertaken of a monograph surveying the present world position, with regard to insecticide materials of vegetable origin, and collecting together the most recent information available on the botany and chemistry of these products. This monograph, produced under the editorship of H. J. Holman, B.Sc., A.R.C.S., D.I.C., A.I.C., of the Imperial Institute staff, and secretary of the committee, has just been published (see p. 182).

In the following series of reports are given the results of examination at the Imperial Institute of the samples of various plant insecticide materials that have been received in recent years. Previous reports on pyrethrum flowers from Kenya and Cyprus and of derris roots from New Guinea were published in this BULLETIN, 1930, **28**, 425, and 1933, **31**, 469. For particulars of the position of the industries in the various countries from which samples have been received reference should be made to the monograph mentioned above.

The precise methods followed in these investigations, particularly in the case of derris samples, have changed somewhat as our knowledge of the chemistry involved has progressed and modification seemed necessary. Though modern methods are more sensitive and give more reliable figures, it can still be said that the results obtained in earlier analyses are in general comparable with more recent results and give a fair indication of the value of the material. In this connection it may be mentioned that the Imperial Institute is collaborating with other scientific institutions and the trade in the work of standardising a method for the commercial evaluation of rotenone in derris root.

For convenience of reference where a number of similar investigations have been carried out, as in the case of pyrethrum and derris, the results have been collected together in tabular form at the end of each section.

In the case of some of the lesser-known insecticides, such as *Mundulea*, where reliable chemical methods of evaluation had not been developed, biological tests were kindly undertaken by the Rothamsted Experimental Station, and the results of these are included.

The wide range of variation in the figures obtained is striking evidence for the need of selection work and proper understanding of the methods of harvesting and preparation. It is also a clear indication that isolated instances of low yields, as in some of these reports, are of no general significance as an index of the quality of product which may be grown in the country in question.

In addition to the materials dealt with in detail the following samples were examined for rotenone and other toxic principles. *Milletia oblata* leaves from Nyasaland, roots of *Paullinia leiocarpa* and *Serjania paucidentata* from Trinidad, and roots of *Phyllanthus* sp., *Moringa oleifera* and *Clibadium vargasii* from Dominica. None of these samples contained significant amounts of the substances tested for in our laboratories.

NICOTINE

Kenya

No. 1.—The sample was derived from a sport which had arisen in a native tobacco in Kenya, and was submitted to the Imperial Institute for analysis in 1935. It consisted of a circular cake of compressed leaf of a dull brown colour. Pieces of midrib were present, and in addition a small amount of extraneous matter. The sample was dry but had undergone some degree of "heating" as evidenced by its unpleasant odour.

The results of examination were as follows:

	Per cent.
Moisture	13·0
Nicotine, on material as received	5·8
Nicotine, expressed on moisture-free material	6·7

Tobacco of this nicotine content is regarded as very satisfactory for nicotine extraction for insecticidal purposes.

Sierra Leone

No. 2.—This was a sample of native-prepared tobacco, which undergoes no fermentation process, but is simply sun-dried and sold in balls. The material, received at the Imperial Institute in 1936, consisted of one of these balls made up of leaves of a dark brown colour ; whole leaves on the outside surrounding a mass of crumpled leaves together with a few seed pods which formed the inside. The leaves were very small, measuring only 4 in. to 4½ in. long and 1½ in. broad.

The results of analysis showed that the material did not contain a high percentage of nicotine, but compared favourably with waste tobacco from factories. The figures were :

	Per cent.
Moisture	14·2
Nicotine, on material as received	2·68
Nicotine, expressed on moisture-free material	3·12

Jamaica

Nos. 3a to 3f.—Six samples of tobacco waste sent from Jamaica in 1938 for examination for nicotine content.

No. 3a.—Tops. This consisted of coarsely-cut pieces of woody material with a small amount of lamina.

No. 3b.—Stems. These were coarsely cut up pieces of woody stem with a pithy interior.

No. 3c.—Roots. The roots were cut up coarsely and a quantity of fine rootlets was present.

No. 3d.—Classed Fongue. This sample was made up of coarsely broken pieces of dark brown lamina.

No. 3e.—Field Fongue. The material consisted of coarsely broken pieces of lamina of greenish-brown to dark brown colour.

No. 3f.—Midribs. These were coarsely broken pieces with a small amount of lamina attached.

The results of the analyses, which are given below, show that samples 3d, 3e, 3f and possibly 3a might be suitable for local nicotine extraction though the content is not very high, but the stems and roots are too poor in nicotine to be of any value for this purpose.

Sample No.	Moisture.	Nicotine, in material as received.	Nicotine, expressed on material containing 14 per cent. moisture.
	Per cent.	*Per cent.*	*Per cent.*
3a. Tops	11·3	0·40	0·39
3b. Stems	8·1	0·11	0·10
3c. Roots	7·4	0·14	0·13
3d. Classed Fongue	13·0	1·29	1·28
3e. Field Fongue	11·8	1·38	1·35
3f. Midribs	14·0	1·08	1·08

Derris

Tanganyika

Nos. 1*a* and 1*b*.—These samples of roots, grown at the East African Agricultural Research Station at Amani, were received at the Imperial Institute in 1935. They consisted of fine roots (1a) mostly $\frac{1}{20}$ in. or less in thickness and coarse roots (1b), of which the majority were between $\frac{1}{4}$ in. and $\frac{1}{2}$ in. in thickness. Both samples proved to have a high rotenone content.

No. 2.—This sample, forwarded in 1937, was grown at Tanga from material imported from Ceylon. It consisted of a mixture of fine and coarse reddish-brown roots.

Nos. 3*a and* 3*b*.—Samples of coarse brown roots (3a) and rootstock (3b) received with No. 2. The plants were stated to have been grown at Sanya, in the Northern Province, from material of the original Amani strain. No. 3a showed a fairly satisfactory rotenone content despite the rather low figure for ether extract. The chemical examination of the rootstock (3b) which included the butt-ends of the roots, showed clearly that only a small proportion of the rotenone contained in the plant is present in this part.

Nos. 4*a and* 4*b*.—Two samples of *Derris elliptica* roots forwarded to the Institute at the end of 1937. They were taken from plants grown at Morogoro on two different types of soil: swampy soil (4a), and dry laterite soil (4b). Both samples contained a mixture of coarse and fine roots, though the proportion of fine roots was greater in the case of sample No. 4a, from the swampy soil. The ether extract and rotenone yield from this sample were also noticeably higher than from sample 4b, though both were of excellent quality.

No. 5.—This sample, consisting of fine and coarse roots in the form of complete root systems, was received through the Crown Agents for the Colonies in 1938. The results of analysis show a high ether extract and a high percentage of rotenone.

No. 6.—A sample received in 1939, and made up of complete roots up to $\frac{1}{2}$ in. in diameter, stated to have been harvested from two plants. In the method of examination used, chloroform extraction took the place of the ether extraction employed for the previous samples, and the rotenone was purified by trituration with alcohol. The figures show a satisfactory percentage of extract and a good rotenone content.

Sarawak

Nos. 7, 8 *and* 9.—Three samples of ground derris root were sent to the Institute for examination in 1935, labelled as *Derris elliptica* (*Sarawakensis*), "Tuba Tedong" (No. 7); *Derris malaccensis* (Sarawak), "Tuba Rabut" (No. 8); and Derris Powder, "Sibu Laut" (No. 9). The precise botanical identity of the plant from which No. 9 was obtained was not known. All three samples were in the form of fine powder, the first two being pinkish-brown in colour

and the last yellowish-brown. The results were not very satisfactory as none of the samples proved to contain a high percentage of rotenone, and the ether extract figures were likewise not particularly good. This is probably accounted for by the fact that derris in powder form is known to lose in rotenone content on keeping.

Seychelles

No. 10.—This was a sample of roots from *Derris malaccensis* plants approximately 18 months old. The material, which consisted of the complete root systems of a number of plants, was forwarded by the Director of Agriculture in 1934.

Nos. 11 *and* 12.—These consisted of roots of *Derris elliptica* (No. 11) and *D. malaccensis* (No. 12), the material of each species being divided into three samples (fine (a), medium (b) and coarse (c)) according to the thickness of the roots. The roots, which were received at the Imperial Institute in 1938, were from 2-year-old plants grown under similar conditions on neighbouring plots, and had been sun-dried after harvesting.

Combining the results of the separate analyses, calculated figures (on moisture-free basis) for ether extract and rotenone content of the whole roots are as follows:

Sample.	Total Ether Extract.	Rotenone, calculated from carbon tetrachloride compound.	Rotenone, purified by trituration with alcohol.
	Per cent.	*Per cent.*	*Per cent.*
No. 11 . .	18·4	7·0	6·2
No. 12 . .	10·4	2·4	1·3

Mauritius

No. 13.—Material of mixed, broken roots forwarded by the Director of Agriculture in 1939. The maximum diameter of the roots was between $\frac{5}{8}$ in. and $\frac{3}{4}$ in., some large nodular roots being present. Results of chemical examination show the extract figure to be rather low, though the content of rotenone is fairly satisfactory.

Trinidad

Nos. 14 *to* 18.—Five samples of roots from plants grown experimentally by the Department of Agriculture, which were received for examination in September 1938. The samples may be described as follows:

No. 14.—*D. malaccensis* (erect). Plot No. 1, planted 1931. Medium and coarse roots, mostly from 0·2 in. to 0·8 in. in diameter, and greyish-brown in colour. A few finer roots were present and a very few coarser ones up to 1 in. in diameter.

No. 15.—*D. malaccensis* (creeping). Plot No. 2, planted 1931. Medium and coarse roots, mostly from 0·2 in. to 0·8 in. in diameter, with a few finer rootlets present and a few coarser roots, up to 1·2 in. in diameter. The colour was mostly dark greyish-brown.

No. 16.—*D. malaccensis* (erect). Plot No. 3, planted 1935. Medium and coarse roots, mostly from 0·2 in. to 0·5 in. in diameter, with a few finer roots. The prevailing colour was greyish-brown, some roots being darker.

No. 17.—*D. elliptica.*—Plot No. 4, planted 1935. Fine, medium and fairly coarse roots up to 0·4 in. in diameter, with a few up to 0·6 in. in diameter. Most of the roots were dark greyish-brown in colour, some being rather lighter.

No. 18.—*D. malaccensis* (creeping). Plot No. 5, planted 1935. Fine, medium and fairly coarse roots, with but few exceeding 0·4 in. in diameter. The colour was predominantly a dark greyish-brown.

The two samples of *D. malaccensis* (erect) (Nos. 14 and 16) proved to be poor in rotenone, but the *D. malaccensis* (creeping) samples (Nos. 15 and 18) were far more satisfactory, both for their rotenone content and the ether extract. It was suggested that the quality of No. 15 might be improved somewhat by the removal of the coarser roots. The *D. elliptica* figures are satisfactory though not especially high.

Dominica

No. 19.—This sample, together with Nos. 20 and 21, was forwarded to the Institute in 1937. It consisted of pieces of fine and coarse roots of *D. elliptica,* up to ½ in. in diameter and dark reddish-brown in colour.

No. 20.—Pieces of fine and coarse roots of *D. malaccensis* (erect) up to ½ in. in diameter and of a dark reddish-brown colour.

No. 21.—*D. malaccensis* (climbing). This sample was made up of complete roots, with a maximum diameter of ⅜ in., and of a dark brown colour. The variety doubtless corresponds to the *D. malaccensis* (creeping) samples mentioned elsewhere in these reports.

The figures for rotenone content of Nos. 20 and 21 are average for the species, but the ether extracts are considerably below normal. The sample of *D. elliptica* was well below the commercial standard for this species.

Fiji

Nos. 22*a and* 22*b.*—These samples, forwarded to the Imperial Institute in 1935, were of *D. elliptica* roots, the former consisting of finer roots than those of No. 22b. The roots in No. 22a ranged from 13 in. to 18½ in. long and $\frac{1}{16}$ in. to ¼ in. in diameter, the thickness of the majority being about ⅛ in. The material was greyish-brown in colour. In Sample No. 22b the roots resembled those of No. 22a in colour and general character, but the thickness ranged from $\frac{1}{16}$ in. to ½ in., the majority being about ¼ in., and the length from 17 in. to 18½ in.

The results of the investigation reveal no marked difference in quality between the two samples; both gave rather low yields of rotenone and ether extract.

EXAMINATION OF DERRIS SAMPLES

Sample No.	Country of Origin.	Moisture.	Total Extract.*	Rotenone, calculated from carbon tetrachloride complex.	Rotenone, purified by alcohol.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
1a	Tanganyika	6·0	20·3	9·8	8·7†
1b	,,	6·9	19·0	9·5	8·4†
2	,,	6·3	11·0	4·2	3·5†
3a	,,	6·6	12·8	5·2	4·4†
3b	,,	10·2	3·3	1·0	0·95†
4a	,,	5·2	22·6	11·0	9·3†
4b	,,	5·1	21·5	8·7	7·4†
5	,,	4·5	19·5	8·2	7·7†
6	,,	7·2	18·0	—	7·6‡
7	Sarawak	10·6	10·3	3·6	3·3†
8	,,	10·4	13·1	2·9	2·3†
9	,,	10·0	11·9	1·7	1·3†
10	Seychelles	6·1	14·9	3·1	2·6†
11a	,,	7·2	12·9	4·9	4·3‡
11b	,,	6·2	18·4	7·0	6·5‡
11c	,,	5·9	18·0	6·9	6·0‡
12a	,,	7·9	8·1	1·2	1·0‡
12b	,,	6·5	9·8	2·4	1·4‡
12c	,,	7·5	10·1	2·4	1·2‡
13	Mauritius	7·1	12·6	—	4·85‡
14	Trinidad	7·6	9·0	1·1	0·8†
15	,,	6·2	14·7	4·9	4·8†
16	,,	6·7	11·0	2·2	1·8†
17	,,	6·6	10·1	5·2	4·3†
18	,,	4·9	22·0	8·6	7·2†
19	Dominica	8·3	3·8	0·8	0·6†
20	,,	6·4	11·4	2·8	2·0†
21	,,	6·0	13·3	4·6	3·6†
22a	Fiji	9·8	9·3	1·8	1·6†
22b	,,	9·9	6·9	1·5	1·3†

* *All extracted with ether except Nos.* 6 *and* 13, *where chloroform was employed.*

† *By crystallisation from hot alcohol.*

‡ *By trituration with cold alcohol.*

MUNDULEA

Union of South Africa

No. 1.—A sample of *Mundulea sericea* (synonym *M. suberosa*) roots sent by the Division of Plant Industry in 1933. The material consisted of rootlets and roots up to 1½ in. in diameter; internally pale yellow and fibrous and externally covered with brown cortex.

As it was believed at that time that the active principles of Mundulea and Derris were the same, the roots were examined for rotenone, but with negative results. From this it was concluded that not more than a trace of rotenone, if any at all, could be present. Acting on the possibility that the reported toxic properties of Mundulea root might be due to other active principles than rotenone, a portion of the sample was forwarded to the Rothamsted Experimental Station. Here the Department of Insecticides and Fungicides kindly undertook to make a biological test with the

material, using *Aphis rumicis* as test-subjects. Laboratory trials with alcoholic extracts gave the following results:

Concentration in terms of root used.	Moribund and dead insects.
Per cent.	*Per cent.*
1·0	100
0·5	50
0·25	20
0·1	10

The roots thus proved to have a definite insecticidal action, but were not sufficiently toxic to be of much economic value.

It is interesting to note that a sample of stems of the same plant received by the Rothamsted Experimental Station from another source in South Africa had been tested and found completely devoid of activity, whereas a sample from India had proved more toxic. This latter was similar in its physiological action to sample No. 1 described above in that the toxic effect was a delayed one.

No. 2.—A sample of *Mundulea sericea* bark forwarded by the Division of Plant Industry in 1936. The bark was in pieces mostly 4 in. to 5 in. long, about ¼ in. broad and $\frac{1}{32}$ in. thick. The outer corky layer was largely absent from most of the pieces, exposing a green, fairly smooth surface. The fracture was brittle.

The examination for rotenone carried out at the Imperial Institute gave negative results, and a biological test was kindly undertaken by the Rothamsted Experimental Station. Concentrations of 1 per cent. or less (alcoholic extract) gave negative results indicating either that the sample possessed very poor insecticidal activity or else that the alcohol did not extract the active principles. It may be mentioned that a sample of *Mundulea suberosa* leaves from India tested by Rothamsted at the same time as No. 2 proved completely toxic at 1 per cent. (alcoholic extract).

Tanganyika

No. 3*a*.—This sample consisted of bark of *Mundulea sericea* received during 1935. The material was in small pieces most 1 in. to 1½ in. in length, ¼ in. to ½ in. in breadth, and $\frac{1}{64}$ in. to $\frac{1}{32}$ in. thick. The outer surface of the bark was dull and rather dark greyish-brown, while the inner surface was yellowish-brown to brown.

Examination of the sample for rotenone gave negative results, but qualitative tests showed the presence of saponin and alkaloids.

No. 3*b*.—A further sample of Mundulea bark was submitted for examination by the East African Agricultural Research Station, Amani, in 1936. The results of the examination were as follows:

	Per cent.
Moisture	7·7
Ether Extract	4·6
Rotenone	0·7
Rotenone, expressed on moisture-free material .	0·8

TEPHROSIA

Uganda

Nos. 1a, 1b and 1c.—Three samples of leaves of *Tephrosia vogelii* forwarded to the Institute in 1936 for investigation of their insecticidal properties. They were:

No. 1a.—Leaves from an estate in Toro.

No. 1b.—Leaves from white-flowered plants on the Kampala Plantation.

No. 1c.—Leaves from purple-flowered plants on the Kampala Plantation.

The quantity of material sent was insufficient for the chemical estimation of tephrosin, the active principle to which the insecticidal properties of this plant are largely due, but biological tests were kindly undertaken by the Rothamsted Experimental Station. The test-insects used were *Aphis rumicis*, and all samples gave positive results.

In carrying out these tests the leaves of each sample were separated from the stalk and alcoholic extracts made. These were diluted with 0·5 per cent. saponin in aqueous solution, each concentration containing 5 per cent. alcohol. The results of the tests are shown in the following table:

Concentration of leaf, gm/100 cc.	Percentage of Insects Paralysed. No 1a.	No 1b.	No 1c.
1·0	100	100	100
0·5	100	100	100
0·25	25	25	85
0·1	5	10	5
0·05	5	0	5
Control spray: Saponin 0·5 per cent. Alcohol 5 cc./100 cc.	3	3	3

Union of South Africa

No. 2.—A sample of roots of *Tephrosia toxicaria* from Natal received at the Imperial Institute through the Royal Botanic Gardens, Kew. Examination showed the roots to contain 1 per cent. ether extract and only a trace of rotenone.

PYRETHRUM

Tanganyika

Nos. 1a and 1b.—These two samples of flowers grown at Dabaga, in Iringa Province, were received for examination in March 1937 and served as a means of comparing the quality of the crop grown on two different soils in the same locality. No. 1a was grown on grassland soil and No. 1b on forest soil. Both samples consisted of pyrethrum of normal appearance, but contained rather too large a proportion of over-ripe flowers. This was especially true of the

grassland sample, while in the case of the forest sample there was an excessive amount of stalk present.

The total pyrethrin content of the flowers grown on forest soil proved higher than those from grassland soil. Both samples fell somewhat below the Kenya flowers in pyrethrin content, but were comparable with the Dalmatian and Japanese products. The high proportion of over-ripe flowers present in the samples indicates that they were picked too late, and are therefore not truly representative of the crop. Doubtless a slightly higher figure for the pyrethrin content would have been obtained by harvesting at the optimum time.

No. 2.—Flowers grown in the Mbulu District of the Northern Province and received at the Imperial Institute in May 1937. The sample was in good condition and free from stalk; in most cases the disc-florets were fully open or just opening. The analysis shows a satisfactory content of total pyrethrins, and the ratio of the amount of pyrethrin I to that of pyrethrin II is normal.

No. 3.—This sample consisted of flowers grown in the Mbosi area of the Southern Highlands Province, and was received at the Institute for examination in August 1937. The material was in a rather badly-broken condition and included a quantity of loose achenes and florets, while the amount of stalk present was more than is normally desirable. The flower-heads themselves were fully-open and mostly over-ripe, though some half-open flowers were included, and the sample as a whole had a dark, burnt appearance as though over-dried.

The figures for analysis show only moderate amounts of pyrethrins, considerably below the standard of Kenya flowers. Doubtless these low results are in part due to late harvesting.

Nos. 4*a and* 4*b*.—Samples of flowers grown in the Mufindi area and harvested at slightly different stages. The material, which was in good condition and free from stalk, was received in October 1937. The first sample (No. 4a) was described as being picked when the disc-florets had "opened about 30 per cent." As received, the disc-florets were mostly partly open. The second (No. 4b) was picked a little later than the first sample, the disc-florets having "opened approximately 70-90 per cent." In this, as the sample was received, the disc-florets were mostly entirely open, a small proportion of the flowers being slightly over-ripe.

The results of analysis show both samples to have a very good pyrethrin content, comparing favourably with Kenya pyrethrum. The figures for No. 4b are slightly higher than those for No. 4a, indicating that the sample was a little riper than No. 4a, and from the appearance of the flowers was probably harvested at the optimum time.

Nos. 5*a*, 5*b and* 5*c*.—Samples received early in 1938, representing pyrethrum grown in the Dabaga area of the Iringa District, one (5a) on grassland soil and the other two (5b and 5c) on forest soil.

No. 5*a*.—"From grassland soil: picked about September and

October." This consisted of flowers very variable in size, though mostly small. A proportion of the disc-florets had been shed, suggesting the flower-heads had reached somewhat too advanced a stage of maturity before being picked.

No. 5b—"From forest soil: picked about September and October." This again consisted of small flowers, but more uniform than those of No. 5a. They had been picked at about the correct stage of ripeness.

No. 5c.—"From forest soil: picked towards end of July." This was made up of flowers very similar in appearance to those of sample 5b, though some showed signs of mould.

All three samples were fairly free from stalk.

The results of analysis show a good pyrethrin content, and no marked difference between the samples grown on the different soil types. The quality was an improvement on Samples 1a and 1b sent from the same locality in 1937; these last being somewhat over-ripe when harvested.

No. 6.—This sample of pyrethrum powder from Mondul in the Arusha District was submitted to the Imperial Institute in May 1938. It consisted of a fine yellowish-brown powder, and proved on examination to be low in pyrethrins. It is well-known that ground pyrethrum loses activity through decomposition of pyrethrins on keeping, particularly on exposure to sunlight. In order to test whether exposure had been entirely responsible for the low pyrethrin content of this sample, the Imperial Institute suggested that a sample of unground pyrethrum flowers from the same locality should be forwarded for examination and comparison with the powder.

No. 7.—A sample of unground pyrethrum flowers from the same estate as No. 6 was sent later in 1938, for comparison with that sample, in accordance with the suggestion made by the Imperial Institute. The flowers were of good colour, most of the disc-florets were fully open, and there were also present a number of empty discs and loose florets. The results of the analysis show the flowers to be of good quality, only slightly below the standard for commercial Kenya pyrethrum, indicating that the lower pyrethrin content of Sample No. 6 was largely due to deterioration of the powder.

No. 8.—The material of this sample represented the first harvest from an estate at Ol Donyo Sambu, in the Arusha District, and was received at the Imperial Institute in November 1938. The flowers had only one-quarter to three-quarters (2 to 5 rows) of the disc-florets open. The figures obtained for the total pyrethrin content indicate good quality flowers, only slightly below the Kenya commercial consignments, and it is probable that a somewhat higher value would have been obtained had the flowers been harvested a little later (when four or five rows of the disc-florets had opened).

No. 9.—A sample from Mondul, Arusha District, received for investigation in November 1938. The flowers were of good colour, and their stage of development ranged from three-quarters (five rows) to the whole of the disc-florets fully open. A few immature flowers were present and also a few that had shed all their florets, and a number of loose disc- and ray-florets. On the whole, the flowers appeared to have been picked at too advanced a stage of development. The content of pyrethrins I and II proved very satisfactory, and comparable with Samples No. 7 and No. 8, though somewhat higher figures could probably have been obtained by harvesting a little earlier.

No. 10.—This sample was from material grown at Nadungoro Downs and forwarded to the Imperial Institute in November 1938. The flowers were mostly devoid of ray florets and had four to five rows of the disc-florets open, though in a considerable number more than five rows were open. A few of the flowers present had been picked with less than four rows open. The sample appeared to have been harvested at the optimum stage of development and the results of the analysis show it to be fully up to the standard of Kenya flowers.

No. 11.—This sample of flowers grown experimentally in the Lushoto District was forwarded to the Institute in August 1939 in order to find whether the locality is suitable for pyrethrum. The material consisted of dried pyrethrum flowers with ray florets, and in many cases the disc florets were completely open. Although containing a proportion of flowers picked at a later stage than is desirable, the sample proved of good quality, comparable with commercial consignments of Kenya flowers.

St. Helena

Nos. 12*a and* 12*b*.—These two samples of dried flowers (12a) and dried flower stalks (12b) were grown experimentally from seed supplied by the Royal Botanic Gardens, Kew, in 1934. The material was submitted to the Imperial Institute for examination in 1937. Sample No. 12a was free from stalk and consisted of dried flowers in good condition, with the disc-florets just opening in most cases. In Sample No. 12b, which consisted mainly of greyish-green stalks a small quantity of dried leaves was also present, together with a few flowers. The investigation showed the percentage of total pyrethrins in the flowers to be satisfactory, with normal proportions of pyrethrin I and pyrethrin II, while the dried stalks contained only a very small amount of total pyrethrins. The flowers had been gathered a little before the optimum stage of development, when a slightly higher pyrethrin content could have been expected.

No. 13.—This further sample of pyrethrum flowers was sent in 1939 for determination of the pyrethrin content in comparison with that of the previous material (Nos. 12a and 12b) submitted in 1937.

The flowers were in good condition and had been gathered when

most of the disc-florets were fully open. A small quantity of loose ray-florets was present, and in a few cases the disc-florets had been shed. The percentages of pyrethrins I and II proved to be satisfactory, and almost the same as those found in the previous sample of flowers (No. 12a) sent from St. Helena.

Ceylon

No. 14.—The material, which represented flowers from a first experimental picking of plants grown at Hakgala, was submitted for examination in 1939. It was stated that the flower-heads had been dried in the sun after picking.

The material was in good condition, and had been harvested at the right stage of development, but most of the flowers were small, and the colour of the ray-florets rather browner than is usual for commercial pyrethrum. Small amounts of loose florets and dust were present. The investigation showed the material to contain satisfactory proportions of pyrethrin I and pyrethrin II, though not comparable with the standard for Kenya flowers.

EXAMINATION OF PYRETHRUM SAMPLES

Sample No.	Country of Origin.	Moisture.	Pyrethrin I.	Pyrethrin II.	Total Pyrethrins.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
1a	Tanganyika	9·8	0·38	0·41	0·79
1b	,,	9·8	0·48	0·44	0·92
2	,,	8·6	0·52	0·55	1·07
3	,,	10·1	0·40	0·33	0·73
4a	,,	10·4	0·58	0·74	1·32
4b	,,	10·3	0·64	0·76	1·40
5a	,,	7·3	0·56	0·70	1·26
5b	,,	7·2	0·60	0·64	1·24
5c	,,	7·0	0·58	0·64	1·22
6	,,	10·7	0·30	0·32	0·62
7	,,	7·3	0·52	0·64	1·16
8	,,	8·2	0·47	0·74	1·12
9	,,	8·7	0·49	0·65	1·14
10	,,	9·0	0·59	0·80	1·39
11	,,	10·1	0·62	0·73	1·35
12a	St. Helena	8·6	0·46	0·56	1·02
12b	,,	7·5	0·05	0·05	0·10
13	,,	10·0	0·45	0·59	1·04
14	Ceylon	7·3	0·47	0·57	1·04

CHRYSANTHEMUM FRUTESCENS

Tanganyika

A sample of *Chrysanthemum frutescens* flowers was forwarded to the Imperial Institute in 1939 to determine the value of this material as an insecticide. The sample was in good condition, and in appearance resembled normal pyrethrum.

The flowers were examined for pyrethrin content with the following results :

	Per cent.
Moisture	9·1
Pyrethrin I	0·05
Pyrethrin II	0·07
Total Pyrethrins	0·12

It will be seen that the pyrethrin content of the material is insignificant in comparison with commercial pyrethrum flowers. Biological tests undertaken at Rothamsted Experimental Station with a portion of the sample gave negative results, proving the material to have no insecticidal value due to other active principles than pyrethrins.

ARTICLE

THE STORAGE OF FOODSTUFFS IN THE COLONIAL EMPIRE

A MEMORANDUM PREPARED AT THE COLONIAL OFFICE AND CIRCULATED TO COLONIAL GOVERNMENTS

Introductory

IN Chapter IX of the First Report of the Committee of the Economic Advisory Council on Nutrition in the Colonial Empire, consideration was given to the question of the storage and preservation of foodstuffs. In paragraphs 195 and 196 of that Report mention was made that under colonial conditions the main problems of storage are not associated with the preservation of high-grade commodities for the overseas markets, but rather with the maintenance, for local consumption, of stocks from one harvest to the next, from the crops grown by the individual or community, and the preservation of perishable products in order that they may be kept for a time, and if necessary distributed over a wider area.

The suggestion was made that steps should be taken to collect information, with a view to its subsequent circulation, regarding existing storage practices in the Colonial Empire. Much knowledge based upon experience is possessed by colonial peoples in regard to the storage of small quantities of food supplies, but nevertheless there are considerable losses in many areas as the result of faulty storing, and if practice in this respect could be improved, the general food supply position would be more favourable than it is at present. Particularly is this the case where seasonal shortfalls of food are likely to occur as the result of unfavourable weather conditions and consequent crop failures, and the question of satisfactory storage assumes added importance under war conditions when imports of food from outside sources are liable to serious reduction [1].

In the following pages an attempt has been made to summarise available information on the subject in the hope that this may assist in focussing attention on a problem which has a considerable degree of importance under the present circumstances.

General Principles of Storage

The successful storage of foodstuffs necessitates the satisfaction of two requirements (*a*) that the product to be stored, at the time of its introduction into the store, is in a condition suitable for storage, and (*b*) that the conditions of storage are such as to ensure that this state of affairs may be maintained satisfactorily during the period of the storage.

If stored products become invaded by insects or other destructive agencies, treatments may be available to reduce the damage, but it is far preferable to prevent loss by attention to the provision of suitable stores and to the conditions of storage.

When considering storage, foodstuffs may conveniently be classified as follows:

(1) grain crops, with which may be included pulses, and

(2) root crops, including sweet potatoes, yams, cassava, etc.

In addition, there are products prepared from grain such as rice, flour, brans and meals, as well as dried chips and meals prepared from root crops.

Stored grains and meals are liable to insect attack and may also be damaged by the growth of moulds and fungi if the conditions of storage are unsatisfactory, whilst they may also be attacked by rats and mice if they are not adequately protected against them.

Stored grain containing more than 15 per cent. of moisture is liable to "heat" as the result of the commencement of germination and the onset of attack by moulds and bacteria. Such grain is also particularly liable to attack by weevils since the optimum conditions for the existence of these insects in grain occur when the moisture content lies between 17 and 20 per cent. On the other hand, weevils are unable to live in grain containing less than 8 per cent. of moisture, and cannot carry on active life in the absence of an adequate supply of air.

Consequently it is important to ensure that before storage the moisture content of grain be reduced to a value which will remove the liability to "heating," inhibit the growth of moulds and afford some protection against insect attack, while during storage, conditions should provide that the moisture content of the stored grain does not increase by reason of inadequate protection. If these requirements are not satisfied loss is bound to occur; thus experiments carried out in the Federated Malay States in 1928-30 showed that when rice is stored in bags under the conditions which normally prevail in the commercial godowns it is barely edible after eight months. On the other hand when it is stored in bags under clean, rat-proofed and well-ventilated conditions it can be kept satis-

factorily and without appreciable deterioration for a period of two years [3].

As regards the moisture content of stored grains and meals, the factor of safety varies to some extent with different types of product, but it may be said broadly that for satisfactory storage the moisture content should not exceed 12 to 14 per cent. and may with advantage be lower. Maize exported from Kenya is not permitted to have a moisture content in excess of 12.5 per cent., and if maize on receipt at Mombasa has a higher percentage it has to be reconditioned in the maize conditioning plant. This drying plant was obtained through the Crown Agents from Messrs. T. Robinson, of Rochdale, England.

The reduction of the moisture content of grain to safe levels depends to a considerable extent on climatic conditions. Where the humidity of the air is low, grain crops can be dried in the field to satisfactory moisture content. Such conditions exist in many parts of Africa. On the other hand, where the atmospheric humidity is high, drying in the field is not practicable and special measures are required to reduce the moisture content to satisfactory levels; these may take the form of drying on floors or barbecues, or even on the ground by the direct heat of the sun, the grain being spread out for the purpose and turned at intervals, provision being made to protect the grain from sudden showers of rain.

Various forms of grain-drier also exist in which a current of heated air is forced by blowers or suction fans through the grain; the employment of such devices may add materially to the cost if the moisture to be driven off is considerable. Their use is mainly limited to places where large quantities of grain are handled and stored in bulk and it is doubtful whether they are capable of being economically used for the handling of relatively small quantities of grain. Driers of this type were erected and operated during the last war in two West Indian Colonies and in Mauritius, and the experience there gained indicated that under those conditions the artificial drying of grain was a doubtfully economic procedure when the initial moisture is high. The maize conditioning plant operated in Kenya at Mombasa functions satisfactorily at relatively low cost as the reduction of the moisture content of the grain before it is ready for export is generally small.

Not only must the moisture content of stored grain be reduced to a satisfactory level but it must be kept at that level during storage, and in countries where there is marked variation of climate between the wet and dry seasons this may prove a factor of importance. Many grains are hygroscopic and their keeping power is liable to be influenced by the atmospheric humidity at the place of storage. Difficulties in this direction are illustrated by the fact that the length of time for which rice can be stored without deterioration in Burma depends to an appreciable degree on the climatic conditions at the time it is milled, rice milled during the dry season

possessing better keeping qualities than rice milled during the wet season.

Containers for the storage of grain should be dry; they should be protected from invasion of moisture from the ground and also from the entrance of moist air during wet periods, while they should also be insect-proof and rat-proof.

Grain: Bulk Storage

Various methods are used by the peasantry in tropical and sub-tropical countries for the storage of grain, some of which are reasonably efficient.

Provision is made, for example, by the populations in many parts of the Colonial Empire for the careful storage of their grain crops, and each homestead has its stores made of reeds or other material carefully mudded—sometimes only on the inside but more generally on both the inside and outside walls [10]. These stores vary in size and shape, some of them being bottle shaped and spherical as in Meru, or beehive shaped as in Machakos in Kenya. In certain cases the stores are raised on posts from the ground as is common in the villages of Ceylon. In the majority of cases in Africa, the men and women own their crops individually, customs varying with different tribes, and in many areas so individual is the ownership of crops that adult members of a family keep their crops separately in different stores. In such cases the women are expected to feed the husband and the family from the store of food in their possession, whilst the husband, though he may in cases of need supplement her stocks, uses his supplies for the preparation of beer and for the entertainment of guests. In the Northern Territories of the Gold Coast, there is also a store of food in the keeping of the woman which is reserved for the scarcity period and this is the last of the stores in any season to be opened. Yam producers in West Africa equally store their crops individually on wooden racks, which are shaded, but exposed to the air, with the woman providing for the needs of the family and the man using his crops either for sale or for the entertainment of guests.

The grain stores are usually cleaned, and in many cases re-mudded or given a coating of cow dung, before the crop of the season is placed in them, and a considerable degree of knowledge is possessed by the people regarding the keeping qualities of the different types of grain raised. It is generally accepted, for instance, in West Africa that certain yellow-grained guinea corns keep for only short periods of time, whilst harder white-grained types can be stored without damage for lengthy periods. It is held with justification in many parts of Africa that the grain of bulrush millet (*Pennisetum typhoides*) is less liable to damage than is the grain of guinea corn, and again that the grain of *Eleusine coracana* keeps well if dry when stored, and is not so seriously damaged by insects as other grains.

In the drier areas of Uganda, a striking feature of the countryside is the communal storage of grain, in which are stored considerable stocks of grain from one season to another against scarcity or famine. These communal granaries, consisting of a large number of round mudded store houses with grass-covered roofs, are well controlled and maintained, although so far it has not been possible to introduce a satisfactory system of protection against rat damage and the accompanying danger of providing foci for the spread of plague, which is a rat-borne disease.

In Sierra Leone also it is held that rice in which ripe pods of chilli are introduced is less liable to insect damage than where this addition is not made, but whether this claim is justified has yet to be investigated.

Very fairly efficient types of granary for the bulk storage of paddy are in use among Malay rice growers in the Malay States [5]. In the State of Kedah two types of granary occur. In their original forms, they are made of plaited bamboo, but more recently galvanised iron has also been employed. They comprise a larger square type, some of which are capable of holding several thousand bushels of paddy, and a smaller round type which holds a few hundred bushels. They are erected under cover and are raised off the ground on wooden supports which are protected by rat guards. In them paddy can be stored without depreciation for many months ; if the grain is attacked the damage is usually confined to the superficial layers. In some cases the wooden supports on which the stores have been erected are not sufficiently high and the rat guards are occasionally inadequate. Rats are known to be able to make a vertical leap of 2 ft. 6 in. and to crawl around flanges which provide less than 9 in. in total width. Stores to be protected adequately against rats should have their floors not less than 2 ft. 9 in. from the ground and be protected at this height by flanges or pieces of kerosene or petrol tins which extend from the sides of the store or its supports for a distance of not less than 4½ in.

In Nyasaland an attempt was made in 1931-32 with some success to develop the use of communal grain stores of a type originally suggested by the Tanganyika Department of Agriculture. They consisted of a cylindrical mudded container standing on a mudded platform about 4 ft. from the ground. In the final form the top was also mudded and a small manhole cut in the side for filling. It was found that in stores of this type, provided they were fumigated at the commencement of storage, grain could be kept for several months without deterioration [9].

In many parts of Africa and elsewhere, maize, after drying in the field, is stored on the cob in the unhusked condition either in cribs or on beams, shelves or racks in houses. Cobs with tightly fitting sheaths are rarely infested. This method is satisfactory for keeping small quantities of maize for relatively short periods, but

is not generally suitable for storing large quantities for any considerable length of time [2].

Various types of smaller containers have also been evolved by peasant cultivators for the storage of grain. These may take the form of earthen jars or metal containers, and petrol tins have been successfully used. In the Gold Coast, maize stored in airtight petrol tins showed no loss of weight and was free from weevils after eight months, while maize stored in the husk showed a loss of 25 per cent. in weight and was of less attractive appearance [2].

In India, grain stored in metal or earthenware containers has been successfully sealed and kept airtight by covering it with a layer of sand, a sheet of cloth or a piece of iron or wood being placed beneath the sand layer to prevent the grain becoming mixed with the sand [2].

Grain is often stored underground in India and elsewhere in more or less airtight pits. Experiments in Australia have shown this to be an effective method of controlling a number of insects which infest it, the pests being killed by the carbon dioxide given off by themselves and by the grain. This method of storage may be of value where large stocks of grain have to be stored for long periods. In using it the grain should fill the available space so that the store contains as little air as possible [2].

For the large-scale bulk storage of grain the most satisfactory method is in large metal or concrete tanks, which can be hermetically sealed and which are provided with facilities for fumigation. Where, as in parts of South Africa, maize can be dried in the field down to moisture contents of 8 to 10 per cent. it can be stored without deterioration, in tanks with open tops as at these moisture values it is largely immune from insect attack. Where storage at higher moisture content has to be undertaken, closed containers are necessary.

Galvanised iron containers are probably the most efficient and economical for the storage of maize. They can be constructed in sections, the sides being riveted and soldered at the joints; the lower end of each section should overlap the section below to keep out air and moisture. The tank itself should rest on a wooden or concrete platform; it is filled by means of a hole in the roof which can be hermetically closed by means of a flanged lid. Tanks of this sort are widely used in the United States of America for the farm storage of grain.

Grain and Meals: Storage in Bags in Stores

While the bulk storage of grain is the most satisfactory method, storage in bags often has to be undertaken, and in any case bulk storage is not in general applicable to meals, flours or rice. Under these conditions special attention should be paid to the construction of the store and to the conditions of storage. Stores are best constructed of brick or concrete, and they should at least have a concrete

floor; all corners should be rounded to prevent accumulation of debris in which insects may breed, while the sides, floor and roofs should be free from cracks and openings in which insects might harbour. They should be well ventilated and should, if possible, have a through draught. All windows should be screened with fine mesh wire gauze, while double self-closing doors should be provided in large stores. Satisfactory rat-proof granaries have been erected at Colombo in Ceylon and at Port Louis, Mauritius, for the storage of rice in bags [4].

All stores should be rat proofed, since otherwise a large amount of damage may occur, while there is also the danger of providing foci for the dissemination of rat-borne diseases, particularly plague. When grain or meals are stored in bags it is important to prevent them coming into contact with the floor. This can be achieved by stacking in rows on rafters or beams running parallel with the length of the building and allowing space for circulation of air and for inspection. In Southern Rhodesia newly bagged grain is often pigeon-hole stacked in order to hasten drying.

Maize meal does not keep well after it is ground if the germ is not removed, owing to the oil contained in the germ which rapidly turns rancid and imparts an objectionable taste to the product. Machines for removing the germ are on the market. From a nutritional point of view, however, it is undesirable to eliminate the germ, which is rich in proteins and fats and has high nutritive value. One way of meeting the difficulty is to store maize in the form of grain and to grind small quantities as required to meet immediate demands.

Pests and Pest Control

Insects Attacking Stored Grains, Flour and Meals

Grains and their products, meals and similar materials prepared from root crops are liable to attack by a number of insects. These include the following:

(*a*) The grain weevils characterised by their long snouts, examples of which are the grain weevil proper (*Calandra granaria*) and the rice weevil (*Calandra oryzae*). The females may live for 4-5 months and lay from 100 to 200 eggs, from each of which a small grub hatches out and at once starts to feed. The grub or larval stage is passed inside the grain and by the time the grub is fully grown the whole of the grain has been hollowed out, and in this shell pupation takes place. The time of development depends on the temperature; the lower the temperature the longer the life of the weevil, while the life period is also affected by moisture conditions and by the kind of food.

(*b*) The saw-toothed grain beetle (*Silvanus surinamensis*) which derives its common name from the presence of tooth-like projections on the lateral margins of the thorax. Both larvæ and adults feed on flour meals, nuts and seeds of several kinds.

(*c*) The flour beetles (*Tribolium* spp.) which are commonly associated with weevils in grain damaged by the latter although they occur more commonly in flour and meals. They differ from the weevils in having no snout, and are lighter in colour and flatter bodied than the weevils, while the grub does not remain inside the grain but wanders freely through and over its food. The time of development from the egg to the adult is about 40 days.

(*d*) Pea and bean weevils belonging to the genus *Bruchus*—short in body with thick snouts and prominent antennæ. The larvæ are short, thick grubs, which live and complete their development within the seeds of peas and beans. The female deposits eggs on or in the seed pod and the young larvæ penetrate into the developing seed.

A number of moths also attack grain and flour, among which under tropical conditions various species of *Ephestia* (known as the Mediterranean flour moth, the cacao moth and the fig moth) may be cited. These are less important than the weevils but where heavy infestation has been allowed to develop considerable damage may be done.

In addition, there are a number of mites which attack stored grains and foodstuffs and which, although less obvious than the beetles and the moths, occur in enormous numbers and do much damage at times.

The Manner in which Stored Products become Infested with Insect Pests

Infestation of stored products by insects may occur either (*a*) before storage, i.e. in the field or in course of transit from the field to the store, or (*b*) during storage, as the result of placing them in stores which have themselves previously become infested. Infestation in the field occurs in the case of the bean and pea weevils, and it has also been shown that infestation of cacao beans by Pyralid moths originally commences on the plantation ; the moths come in the night and deposit their eggs on the beans exposed on the drying platforms [6]. This type of infestation cannot be entirely prevented, but by proper precautions it may be reduced to a minimum. In Southern Rhodesia it has been established that maize in the fields is infested with weevils from various sources such as farm stores, maize stocked at rail-heads, shelling dumps, etc. The stores become infested by weevilly maize brought in from the fields after harvesting time.

With the liability of produce to infestation in the field it is easy to see how warehouses and granaries may become infested and lead to the infestation of produce stored therein if precautionary measures are neglected. The importance of cleanliness in barns and adjacent buildings from which insects might reach the stores accordingly cannot be too strongly emphasised.

Precautions Against Infestation

The screening of windows and doors can do much to prevent pests from spreading, while good lighting, thorough ventilation and relatively low temperatures are also important as grain moths and weevils thrive best in dark places and a still, warm atmosphere. Store rooms should be completely emptied and thoroughly cleaned at least once a year and all emptied barrels, sacks and other containers should be sterilised before they are used again. This sterilisation may be done by means of dry heat or sun or by use of boiling water. Storerooms can be disinfected by spraying or washing the floor, ceiling and walls with kerosene emulsion, diluted carbolineum or similar disinfectant preparations. Whitewashing the walls and ceilings should also be regularly effected as it assists the detection of uncleanliness and the presence of destructive insects. All rubbish and refuse from the stored product should be regularly swept up and destroyed by fire, particularly from under the duck boards on which bags are stacked : the regular movement of stored material acts as a check on the multiplication of moths and weevils. Fresh material should never be stored with infested material or in storehouses or containers that are not scrupulously clean ; if stores become infected to such an extent that it is in practice impossible to free them from infestation they are better destroyed.

When grain has to be stored in large quantities for a considerable period it is wise to screen it when it is received, since this has the effect of eliminating weevils before they can lay their eggs, and the danger of future infestation is minimised. The longer screening is delayed the greater will be the subsequent infestation.

The problem presented by the infestation of commodities in store is twofold, namely infestation brought in by goods introduced into the store which may be called the "incoming population," and infestation of the store itself which may be called the "resident population." Generally, the destruction of the incoming population can be more easily attained than that of the resident population. Incoming goods can be treated if necessary in special containers, but the stores with their more complex structure and almost infinite capacity for harbouring insects are more difficult to clean up. It often happens that for the treatment of incoming goods, fumigation is wholly satisfactory, but for cleaning storage sheds or warehouses fumigation may be impracticable or may have to be supplemented by the use of sprays. In this connection the following elementary precautions to prevent the spread of infestation deserve consideration :

(1) Infested goods should be segregated. Containers, whether sacks or baskets or drums, which have carried infested goods should not be used again until disinfected or sterilised.

(2) Broken goods, screenings and sweepings are especially prone

to infestation. They should be isolated and sterilised or burned at the earliest opportunity. On no account should sweepings be returned to the main store.

(3) New season's goods should never be stored with old season's goods unless these older goods are known to be clean.

(4) In inspecting goods for the presence of insects the following places should receive special attention :

   (*a*) between adjacent sacks and baskets ;
   (*b*) between these and the walls of the store ;
   (*c*) in the ears and folds at the top of sacks and in the wicker work at the tops and bottoms of baskets ;
   (*d*) at the highest or the darkest places in bulked goods ;
   (*e*) on the floor and especially on the walls of stores near infested goods ;
   (*f*) on the floors of carts, wagons or sledges used in harvesting.

Insects and mites increase in numbers only when they have an undisturbed food supply and breeding ground. Obviously, therefore, neglected heaps of old grain or meals, sweepings, old sacks, and long-accumulated debris in corners and in cracks between floorboards form ideal breeding grounds for them and the first step in the war against these pests is to see that no such breeding grounds are allowed to remain.

The Control of Insect Pests

The main measures available for the protection of foodstuffs in store are fumigation, the use of insecticidal dusts, and perhaps the use of sticky substances to prevent the insects wandering.

Fumigation.—In spite of extensive fumigation carried out in certain countries, the general principles underlying the use of fumigation are still insufficiently appreciated, and the Department of Scientific and Industrial Research has recently thought it necessary to have prepared a pamphlet dealing with the principles of fumigation, from which some of the information given below has been taken by permission of the Department prior to publication.

The first need in fumigation is the complete vaporisation of the fumigant, but in warm countries this difficulty is not likely to arise. The most important cause of failure is the large amount of gas which is liable to be rendered inactive because of its absorption. This may take place on the walls of the fumigation chamber itself, on the surface of the bags, cases or boxes containing the produce, and on the surface of the produce. In consequence, ample allowance should be made for absorption of fumigant, while any fumigant so absorbed must be regarded as having little or no insecticidal effect. Further, on account of absorption of the gas by the product,

the concentration of the fumigant varies inversely with the depth below the surface. Downward diffusion, therefore, does not depend entirely on whether the vapours of the fumigant are heavier than air, and it is essential to apply a dosage strong enough to provide a toxic concentration after the product has taken up all it can. Various products differ in their ability to absorb fumigants. Those rich in fat, such as nuts, absorb a high percentage of gas, and grain very little. Dry food will take up only traces of most gases. Accordingly, longer aeration is necessary after fumigation in the case of foods rich in fat. The concentration and the time during which a fumigant acts influence the depth of penetration of a gas. Therefore, a small dosage of a fumigant for a long time is as effective as a large dosage for a short time.

A further cause of ineffective fumigation lies in the unsuitable piling or stacking of the goods to be treated, and it is necessary that in such cases goods shall be stacked so as to attain the maximum exposure to the fumigant. It has been found, for example, in experiments with cacao in bags laid horizontally that one end of every bag should be exposed. Penetration is affected also by the size and disposition of the " intergranular spaces," i.e. the small spaces between the grains or beans. The proportion of these spaces varies greatly in different products, but is often surprisingly high. Effective circulation and distribution of a fumigant can often be attained by quite simple means ; for example, by the use of large fans or punkahs slung from the roof of the chamber or building and operated from outside by means of a rope or cord.

In general, the important points to observe are that adequate dosage must be given to allow for loss by absorption and leakage, and adequate provision made for effective circulation of the fumigant throughout the goods.

One difficulty in effective fumigation is that it usually results in the absorption and retention of quantities of the fumigant in the goods treated. But this is only a drawback in that it prolongs the period of ventilation of the goods necessary before they are handled or consumed. Even with hydrogen cyanide, which is one of the most penetrating of all the fumigants, " residual " gas can in most products be eliminated by the simple process of ventilation or airing the goods.

Certain goods are quite unsuitable for treatment by fumigation, especially those rich in essential oils, e.g. cloves. But except in special instances, effective ventilation is a fairly reliable safeguard against residual fumigant.

Construction of Buildings and Containers used for Fumigation.— The first requirement for efficient fumigation is a building or container that can be made as airtight as possible, so that the fumigant shall remain in all parts of the space at full strength and for the required time. Loss of fumigant may arise from leakage and from absorption in the materials of construction. In brick and concrete

buildings in good repair the absorption loss is the more important, and the total loss may be such as to render these buildings unsatisfactory for the routine fumigation of goods. Absorption can, however, be greatly reduced by painting exposed surfaces of absorbent material with oil paint, or with cellulose paint, but not with whitewash or distemper. Wood, brick, concrete, mortar, plaster and composition boards are all strongly absorptive, the capacity varying with the quality of the material, density of concrete, hardness of wood, etc.

Accordingly, wherever possible, goods should be fumigated in specially constructed fumigation chambers, and the cost of handling involved in this procedure is more than offset by its reliability and by a saving in fumigant which is otherwise lost through leakage and absorption. Special chambers have fixed characteristics, so that the standard result is readily obtainable. They can be made of a convenient size and should preferably be fitted with a vaporiser and with means for distributing the gas, and should be adapted to secure rapid ventilation at the end of fumigation. The use of tanks provided with a water seal is especially useful in fumigating with carbon bisulphide. The best practicable material for fumigation chambers is mild steel which is suitable for most fumigants. It is practically non-absorptive and lends itself to airtight constructions. A cheaper material which is often satisfactory is bituminous felt, supported on a wooden frame secured to a concrete floor. The joints must be made with a bituminous compound and the felt must be protected from mechanical damage and from contact with liquid fumigant, if this has any solvent action. Brick chambers painted with three coats of good oil paint are also satisfactory. When no proper fumigation chamber is available a water-tight barrel covered with double-thickness wrapping paper, or an ordinary bin with a properly fitting lid, sealed with paper and paste, may be effectively used for fumigation on a small scale. When no fumigation chamber is available, bags of grain or loose grain may be piled together, covered with a good tarpaulin and then fumigated. These methods give fairly satisfactory results provided the barrel or tarpaulin is gas-tight.

Fumigants Used and Conditions of Fumigation.—In the Colonial Empire the choice of fumigant is restricted and may be still more restricted in war time. It is probable that in actual practice only two fumigants need be seriously considered, carbon bisulphide and hydrogen cyanide.

Carbon bisulphide is by far the most commonly used, although its vapours are highly inflammable and explosive when mixed with air in certain proportions ; it is also noteworthy that it is not very effective against the eggs of insects and for this reason fumigation, if efficient, should be undertaken twice, the second application being to destroy insects which may have been in the egg stage during the first fumigation. The main advantage of carbon bisulphide is that

it can be used in almost any type of chamber or container. Ethylene dichloride is often employed as a substitute for carbon bisulphide when the fire hazard cannot properly be controlled. Its vapour is slightly inflammable, and both it and carbon bisulphide are frequently mixed with 25 per cent. of carbon tetrachloride to reduce the risk of fire. These mixtures are, however, unstable and not satisfactory. Carbon bisulphide is applied by sprinkling evenly over the surface of the grain to be treated by means of a watering can at the rate of from 1 to 3 gals. per 800 bushels of grain, depending upon the temperature of the grain and the tightness of the bin. If the depth of the grain in the bins is more than 5 ft. it is advisable to introduce the fluid to below this depth by means of a pipe having openings at frequent intervals along its length. The use of a tarpaulin to cover the grain after the fumigant is applied will help in confining the vapour. Higher concentrations are required if the gas cannot reach the pests so easily.

It seems, however, that under war conditions some difficulty may be experienced in obtaining carbon bisulphide in Colonial dependencies, since the material was usually conveyed only on foreign ships, because charges and conditions of transport on British ships were onerous. It seems certain that they will be still more onerous under war conditions.

An alternative fumigant is hydrogen cyanide. It is one of the oldest and, when properly handled, one of the most efficient. It is, however, very dangerous to man even in small quantities if inhaled and the strictest supervision of its use is necessary. The original method of using hydrogen cyanide was to generate it by the "pot" method from potassium cyanide and dilute sulphuric acid. This method is still employed, but is not really satisfactory for large-scale work. In temperate countries liquid hydrogen cyanide is now widely used, but it would require special packing under tropical conditions and its transport is difficult. The most promising form of hydrogen cyanide for tropical use consists of hydrogen cyanide absorbed on some mineral earth or on papier mâché discs. Two widely used proprietary brands of hydrogen cyanide are the fumigant known as "Zyklon," originally a German product which consists of hydrogen cyanide absorbed in an inert earth, and "Cyanogas," an American product consisting of a commercial form of calcium cyanide. It is probable that one or other of these brands and papier mâché discs may be found most suitable under Colonial conditions. The gas is generated from these by simple exposure to air.

Calcium cyanide may also be employed and whilst it may have the disadvantage that the gas comes off slowly, this in turn has the advantage that the slow building up of a concentration of gas is less likely to lead to high absorption of the gas by the goods than a rapid building up of a high concentration. The substances above mentioned are easily portable, reasonably easily handled, readily

measured out to give the various dosages required, and can be spread out as required to ensure good distribution of gas.

The best method of determining the conditions for fumigation is as follows:

(1) Make a thorough survey to identify the insects completely and to find out exactly the conditions under which it will be required to kill them.

(2) Find out, by experiment if necessary, the concentration of the selected fumigant and the period of exposure required to kill them.

(3) Find out, by experiment if necessary, the amount of fumigant which must be used and the best method of application so that the requisite concentration shall be maintained at every point, in the warehouse or in the goods, where there may be an insect to be killed.

Sprays.—Many storage buildings, particularly those in tropical countries, are so constructed as to render fumigation difficult. Insect infestation in such buildings is probably best tackled by means of sprays. Insecticidal sprays may be divided into two types; those which rely on a direct hit, whereby the insect is thoroughly wetted, and those which, after atomisation, ultimately settle on the insects. It is only in rare circumstances that a direct hit can be obtained on stored products insects and accordingly an atomised spray is essential. A good one consists of an extract of pyrethrum carried in a white oil (kerosene).

Spraying equipment for this type of spray is available. It requires the use of an air compressor which may be driven by a petrol engine and particulars of the equipment are obtainable from Sterilectric Co. Ltd. and Messrs. Charles Austen & Co., both in London.

Dusts.—It is well known amongst colonial producers that seeds required for planting can be kept effectively free from insect attack if they are stored in vessels or tins with dry wood ashes. Experiments made by Squire in British Guiana have shown that weevil damage in rice can be materially reduced by the addition of less than 1 per cent. of calcium carbonate (precipitated chalk) whilst in the Federated Malay States it has been found at the Government Rice Mills in Perak that the treatment of stored rice with 5 per cent. slaked lime affords satisfactory protection from insect attack. In British Honduras it is a common practice to add lime when maize is stored in the cob in heaps or bins, with beneficial results.

In recent years the use of dusts for the protection particularly of grain and cereal products has become more and more general. It is unfortunate that at present no clear understanding of the action of these dusts has yet been attained and there is considerable controversy regarding it. From the practical man's point of view,

however, the main point is that these dusts are said to be surprisingly effective and, further, the variety of mineral dusts which are effective is considerable. Of the natural mineral dusts, the best known and probably the most effective is a naturally occurring rock phosphate widely known in Egypt under the name of "Katelsousse." This particular dust has been so generally successful that it is now marketed on behalf of the Egyptian Government by Imperial Chemical Industries Ltd., under that name.

Other effective dusts consist of pure silica and one of these, known under the proprietary name of "Naaki," has been widely used in Germany and elsewhere. It is a German product and will in consequence not be available during the War. Other simple mineral dusts are precipitated chalk, slate dust and china clay. It is quite probable that a number of naturally occurring earths may prove effective. Some firms market or are about to market dusts for which they claim very high efficiency, and particulars of these can be obtained from Imperial Chemical Industries, Ltd., and Messrs. Peter Spence & Co.

The use of dusts is simple and consists merely in the mixing of the dusts with the grain or other product to be protected. Their general use is for the protection of grain and seeds, particularly pulses. It is worth noting that while experiments on the elimination of these dusts prior to milling and baking of grain are still in progress, the general opinion is that this elimination need present no difficulty, and further that many of the dusts mentioned are innocuous to the alimentary tract. Where dusts such as lime or powdered chalk are used in stored rice their elimination occurs when the rice is washed, as is customary, prior to cooking.

Of all the methods of protecting grain and seeds in particular against insect attack it would seem that the use of dusts is much the most promising.

Sticky Bands.—Many insects which affect stored products may be partially controlled, or may at least have their movements restricted, by the use of sticky substances, applied in a band to the walls or floors of storage buildings. Such substances are similar to those used for banding fruit trees. These sticky bands are of particular use when dealing with migrating caterpillars. They are also of use in isolating infested piles of goods. For such purpose, the bands may be applied to the floor.

It is important to remember that in dusty buildings the surfaces of the bands will rapidly become coated and may thus allow insects to pass over without becoming trapped. Care should be taken to ensure that the sticky surface is maintained in a fresh condition.

Commercial forms of adhesive for grease-banding of trees and banding of warehouse walls are available; but it is quite probable that bird-lime may be readily procured or made. The making and use of it is prohibited in some countries for bird-liming, but doubtless knowledge of its manufacture and use still persists.

The Storage of Root Crops

The storage of tropical root crops in a fresh condition is a more difficult problem than the storage of grain owing to the large amount of water they contain. There is a marked difference however in the case of storage of different kinds of produce. Thus yams are comparatively easily stored, while it is practically impossible to store cassava satisfactorily for any length of time once the roots have been dug.

The most satisfactory method of storage of sweet potatoes and cassava when the preservation of considerable quantities of such products is involved is to slice them and to convert them into dried chips. Slicing into pieces about half an inch thick, with or without peeling, and drying the slices in the sun by exposure on a drying floor is a common practice in parts of Africa. The process presents no difficulty except that the slices require to be protected from rain during drying since if they are wetted they are liable to become leathery and an unsatisfactory product results. Chipped or sliced root crops can be stored in the same way as dried grains and the same precautions require to be observed, as they are equally liable to become damaged by insect attack or mould growth.

Yams

For storage in a fresh condition it is important that the tubers should be fully ripe before they are lifted. They are ready for digging when the foliage has become dry. So long as dry weather persists the tubers can be left in the ground, as is common in parts of West Africa, and lifted as required for consumption, but the usual practice is to harvest the yam crop as soon as it is ripe. The tubers should be dug very carefully so as to avoid bruising, as bruised tubers do not store well. After lifting, the tubers should be left exposed to the air for a few hours and then stored on shelves in a well-ventilated and cool shaded room or store in layers three or four feet deep. Yams are also stored in carefully-packed heaps within weatherproof buildings and sometimes in pits. The latter method cannot, however, be recommended unless the soil is thoroughly dry and likely to remain so.

Buds and eyes should be removed as soon as they show signs of sprouting, while bruised tubers are liable to attack by moulds, and if not removed they should be treated with slaked lime to prevent spread of infection. Under all conditions of storage yams require to be regularly inspected to ensure the removal of all diseased tubers, otherwise infection will spread rapidly, resulting in considerable loss. Under favourable conditions yams can be held in storage for several months, some varieties being much more suitable for lengthy periods of storage than others.

Cassava

Cassava roots do not store well for any length of time after they have been removed from the ground. Under certain climatic conditions it is dangerous to attempt to do so. The crop can, however, particularly in dry areas, be allowed to remain in the ground for several months before deterioration sets in and the most satisfactory method of storing in a fresh condition is to allow the crop to remain in the ground, digging supplies as required for immediate consumption. Certain varieties of cassava can be left undug for much longer periods than others without undue detriment to the starch content of the tuberous roots.

Cassava lends itself very well to the preparation of dried chips and if for any reason it is impracticable to leave the crop in the ground this is the best procedure. In wet districts or in areas liable to insufficient drainage, cassava cannot be satisfactorily left undug, and if production is in excess of consumption needs, the surplus roots should be washed and peeled and then converted into chips or meal. When chips are required for use they may be pounded and sieved to remove the fibre from the meal.

Cassava meal may also be prepared directly from the fresh cassava, as is the usual practice amongst the aboriginal Indians in British Guiana and the Mayas in British Honduras. In the former colony, the roots are cleaned and then grated upon what resembles an English grater which has been beaten out flat and nailed to a small piece of board. The resulting meal is then stuffed into a basket-like cylinder which has loops attached to either end. One of these loops is attached to a beam in the house, whilst through the lower loop is passed a stout stick which is pulled upon so that the wicker cylinder, owing to the pressure, gradually becomes longer and longer. The watery contents so expressed are collected and boiled to form the cassareep which is used for the preservation of meat. The meal remaining in the cylinder is then taken out and rubbed through a sifter. It is then either dried in the sun or baked into thin cakes on large flat iron plates. Cassava meal and cakes form an important item of the diet of the Indian tribes of tropical South America.

Sweet Potatoes

Considerable attention has been given to the storage of sweet potatoes in the United States of America, and a technique of storage which has apparently given satisfactory results has been evolved there [7]. The essential points of the process are a preliminary curing process of ten days to two weeks duration at a temperature of 80° to 85° F., followed by storage in specially-constructed stores at a temperature of 55° F. Such conditions are, however, unattainable under normal conditions in the tropics. Various methods have been attempted under tropical conditions

and storage in pits or clamps has on the whole given the best results. In some recent trials in Barbados, the clamps were prepared by digging out the soil to make a shallow circular depression 3 to 4 inches deep and about 3 feet in diameter. The potatoes were stacked in this in a conical heap. The heap of potatoes was then covered with trash and a layer of soil placed over the trash. This method of storage was considered to be very successful, and to be quite practicable in areas where pests affecting sweet potato tubers are not prevalent [8].

Results in Trinidad have also shown that under suitable conditions sweet potatoes can be stored in this way for about two months in fairly good condition with a loss in weight of about 15 per cent.

Some varieties keep very much better than others, and it is generally held that the red-skinned types are to be preferred for storage to the white or yellow-skinned types.

In storing sweet potatoes care has to be taken to protect the skin from injury by bruising or cutting, as the skin is very delicate and if it sustains injury decay spreads rapidly.

Acknowledgments

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NOTES

Obituary.—It is with very deep regret that we announce the death of Mr. J. E. W. Flood, C.M.G., a member of the Board of Governors of the Imperial Institute, and of Mr. F. Adams Smith, F.R.I.B.A., F.S.I., and Mr. W. Thompson, J.P., members of the Consultative Committee on Timbers.

J. E. W. Flood.—Mr. Flood, who died on April 9, 1940, at the age of 53, was born in Dublin. He joined the Colonial Office in 1910, becoming head of the West African Department in 1927, and six years later head of the Department dealing with Kenya, Uganda and Zanzibar. In 1937 he was appointed a member of the Board of Governors of the Imperial Institute, and in January 1938 he left the Colonial Office to become one of the Crown Agents for the Colonies.

During his short association with the Imperial Institute Mr. Flood brought to the deliberations of the Board of Governors and of the Managing Committee, of which he was a member, a wide knowledge of African affairs and administration. Mr. J. A. Calder, C.M.G., Assistant Secretary, Colonial Office, in a tribute to Mr. Flood, writes: "As an official colleague his outstanding characteristics were ability, industry and good humour. No point was too small and trivial; no problem was too involved and difficult. By his premature passing we have all suffered a grievous loss."

F. Adams Smith.—Mr. Adams Smith, Senior member of the firm of F. Adams Smith & Son, Architects, died on September 22, 1939, in his 82nd year. In his professional capacity he was associated for many years with the Midland Bank. An ardent churchman, he gave up much of his time in assisting Churches and Synagogues in matters of real estate, in which he had considerable skill. In later years he devoted himself to the charitable and educational work of the Worshipful Company of Carpenters, of which he was Master in 1927. He was nominated to represent the Carpenters' Company on the Imperial Institute Consultative Committee on Timbers in 1926, and his great interest in the development of the use of Empire timbers proved of considerable value to the Committee.

W. Thompson.—The death of Mr. Thompson on April 27, 1940, at the age of 80, removes a prominent figure in the timber industry of this country. He was a member of the firm of Pattrick and Thompsons, Ltd., of King's Lynn, and took a leading part in the activities of the Timber Trade Federation, of which he was Vice-President in 1918-19. Since 1929 he had been one of the representatives of the Federation on the Imperial Institute Consultative Committee on Timbers, where his knowledge of the softwood trade was of great value. Throughout this period his advice and assistance had been highly appreciated, while as in other fields of Mr. Thompson's activities he was held in cordial personal regard.

Insecticides.—A monograph entitled *A Survey of Insecticide Materials of Vegetable Origin* has just been published by the Imperial Institute (Crown 8vo, boards, pp. vi + 155; price 3*s*. 6*d*., 3*s*. 11*d*. by post).

This monograph, which has been produced under the editorship of H. J. Holman, B.Sc., A.R.C.S., D.I.C., A.I.C., of the Plant and Animal Products Department, is an outcome of work of the Institute's Consultative Committee on Insecticide Materials of Vegetable Origin. With the wide range of Colonial and trade interests represented on this Committee, besides the scientific institutions, it has been possible to draw on expert opinion covering all the varied aspects of the subject. In addition to this, first-hand information on the position in overseas producing and consuming countries was obtained through the kind co-operation of Government Departments and Official Representatives in London in arranging for the circulation of a questionnaire drawn up by the Institute.

After a brief introduction the text of the monograph is divided into five parts under the following headings: Alkaloid-containing Materials; Plants containing Rotenone and Allied Compounds; Pyrethrum; Quassia; Plant Oils. Part I is mainly devoted to an account of nicotine and anabasine, but includes also a number of plant alkaloids of minor importance, such as those of Hellebore, Delphinium, etc.; while in the second part recent work on Tephrosia and Mundulea is described, after a detailed treatment of Derris and Lonchocarpus. The final section on plant oils gives brief notes on various essential oils and fatty oils.

In the treatment followed, an account is given of the history and introduction of each of the more important insecticides, followed by sections dealing with the chemistry and occurrence in the plant of the toxic constituents, botany, physiological action on insects and application in pest control, and methods of evaluation. A detailed statement is given in each case of production and trade, together with information on the progress of experimental cultivation in the British Empire.

It is as a source of information on the position of production and trade for different insecticides that the monograph is likely to prove particularly useful. Where it has been necessary through limitations of space to deal in less detail with some aspects of the subject the comprehensive bibliography of nearly 400 references will prove of considerable value.

Adlay.—Adlay is the Philippine name for the grain of *Coix lachryma-jobi* L., also commonly known as "Job's tears." The plant occurs in the wild state in the warmer parts of Asia and Africa, and has been introduced into America, where it is also sometimes now found wild. There are a number of varieties, the cultivated forms being known collectively under the name "mayuen." These are grown in certain districts of India, in Ceylon, Malaya,

Japan, the Philippines, and other eastern countries. The hulls of the wild form are hard and the seeds are used in some parts of the world for making beads and for other ornamental purposes. The cultivated variety, however, has soft hulls which are easily removed from the kernel, and in recent years it has been suggested in the Philippines and other countries that the grains should be grown as a substitute for rice and wheat.

According to Wester [1] adlay does best on a rather friable, loose to loamy, fairly rich soil, and should not be planted on heavy clayey lands. It requires a good rainfall during the growing season, but heavy rains are not harmful provided the soil is well drained. In the Philippines it grows well from sea-level up to at least 3,000 ft., whilst in Ceylon and India it will grow up to 4,000 and 5,000 ft. respectively. Details of the methods of cultivating the crop will be found in the literature listed at the end of this note [see especially No. 6].

The following analyses of adlay, in comparison with wheat and rice, are given by P. J. Wester [1]:

	Adlay (whole grain).	Adlay (hulled).	Wheat.	Rice.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture . . .	10·02	10·91	10·62	11·88
Protein . . .	8·23	11·27	12·23	8·02
Carbohydrates (starch, etc.) . . .	49·86	68·83	71·18	76·05
Fat	8·87	6·65	1·75	1·96
Crude fibre . .	14·08	0·45	2·36	0·93
Ash . . .	8·94	1·89	1·81	1·15

The composition of three varieties of adlay grown in Ceylon has recently been investigated by A. W. R. Joachim, S. Kandiah and D. G. Pandittesekere [5]. The recorded analyses of the hulled grain are as follows:

	Adlay.		
	Yellow.	Purple.	White.
	Per cent.	*Per cent.*	*Per cent.*
Moisture . . .	11·3	10·2	10·1
Protein . . .	10·3	11·7	12·1
Carbohydrates . .	74·3	73·1	72·7
Ether extract . .	3·1	3·8	3·8
Fibre . . .	0·29	0·32	0·31
Mineral matter .	0·70	0·87	0·99
Calcium . .	0·005	0·006	0·006
Phosphorus . .	0·30	0·40	0·51

It is pointed out that adlay compares favourably with other grains as regards protein and fat content, but the mineral content of the Ceylon material is low. It is also low in fibre, and in this respect is very similar to rice. Its phosphorus content (0·40 per cent.) is relatively high, but it is extremely deficient in calcium, even more so than rice. So far as the essential minerals are concerned adlay is an unbalanced food and cannot be used like kurakkan

(*Eleusine coracana*), which is rich in calcium (0·37 per cent.) to supplement the deficiency of rice in this element.

Milling and baking trials carried out with adlay flour in the Philippines showed that the flour was suitable for baking purposes provided a proportion of wheat flour was mixed with it [2]. The grain is stated to be a good substitute for rice, for which purpose it may be boiled whole or partly broken. The offals of milling can be used as food for poultry and farm animals.

Up till now, adlay has not become of economic importance because of certain disadvantages it has, compared with rice, which keeps better than adlay and is better adapted to preparation for food in the mortar and pestle used by natives. Rice also requires a shorter growing season than adlay. On the other hand, adlay has a larger yield, requires less labour in cultivation, and could be harvested by modern machinery. The loss of weight on hulling adlay is about 30 to 40 per cent., which is more than that in the case of rice, according to the Philippine authorities, but in Ceylon the loss is said to be about 70 per cent. This variation may possibly be accounted for by differences in the strains grown in the two countries. The yield of grain per acre also varies in the two countries, as much as 3,000 lb. or more of unhusked grain being recorded in the Philippines, whilst in Ceylon the yield is said to range from 1,400 to 1,750 lb. (equivalent to 350-500 lb. of edible grain), although under favourable conditions yields of 2,000 lb. have been obtained.

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RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

Soils

Montserrat.—The following account of investigations concerning soil erosion control is contained in the report for the half-year ended December 31, 1939, furnished by Mr. W. E. Bassett, Curator.

Most of the crops grown in Montserrat are planted on banks which follow roughly the contours of the land. These crops are planted annually, and every year the banks are re-made by the use of hoes, and always by dragging the soil downhill. In weeding with hoes a similar method is followed, the cultivator facing uphill and drawing the soil down towards him. There is practically no level land in Montserrat, and the methods of cultivation just described are followed whatever the gradient. Considerable amounts of soil are thus moved every year, and in almost any field or plot of land which has been cultivated as a unit for a few years there is a small escarpment along its upper boundary, and soil is heaped up along its lower boundary.

It appears that this practice of always pulling the soil downhill when cultivating it with hoes is the most serious factor in the problem of soil erosion in Montserrat at the present time. The most obvious remedy would appear to be for the cultivator to work facing downhill instead of uphill, and throughout the seven acres or so of gently sloping land which comprises the arable portion of the Botanic Station this method is being followed. At first the labourers complained of the strain and extra labour which was, they said, entailed in dragging soil uphill instead of down. However, they have now become accustomed to the new method, and seem to be able to work as easily and quickly by it as by the old way. Whether or no any new difficulties will arise from the change from a long established method to a new one remains to be seen. It must be added that it would probably prove to be impossible to follow the new method on very steep slopes.

An observational experiment laid down in connection with soil erosion control was described in the two previous half-yearly reports. Only general observations on the results of this experiment can be made at present. The year 1939 was comparatively dry, and very little soil erosion caused by the movement of water was seen either on the experimental area or on lands adjoining it.

The general cultivation of the experiment was carried out by the usual local methods, and the effects of dragging the soil downhill with hoes was very marked.

The clearing of stones and boulders, with which to build the stone walls, from the cultivated land facilitated tillage.

The grass strips provided a useful supply of material suitable for mulching, composting or, in the case of the elephant grass and Guinea grass, for fodder.

A small portion of the Agricultural Department's cotton seed multiplication plot is being contour ridged as a further observational experiment and demonstration in connection with soil conservation, and the Department is also experimenting with, and demonstrating, the preparation and use of composts.

Beverages

Cacao

Gold Coast.—The following statement relating to investigations on cacao carried out by the Department of Agriculture is contained in a report for the half-year ending December 31, 1939, furnished by the Director of Agriculture.

Botanical and Plant Pathological Investigations.—Extensive observations on " Swollen Shoot " and " Dieback " in cacao have been continued, though the relationship between the two is still obscure. In most cases the swollen shoot condition does not appear until the trees are in a fairly advanced stage of die-back. In some instances, however, the swollen shoot condition appears when the trees are in an apparently good state of health (i.e. still bearing a good canopy of leaves). In all cases, however, death of the trees follows fairly rapidly.

The most significant advance in the study of " Swollen Shoot " has been made at Tafo Station, where buddings made by the Botanist of swollen shoot bud scions on to healthy stocks have given rise to the typical swollen shoot symptoms in the stock. Still more striking evidence of swollen shoot transmissibility was provided by a graft made in June, a swollen chupon being grafted to one branch of a healthy seedling. The graft callussed successfully, but by September the grafted branch of the stock had been killed back. In October swelling began on the other branch of the stock, which is now obviously affected by swollen shoot. In this case the transference of the infection against the transpiration stream strongly suggests a virus. To date all surviving budlings and grafts of more than six months union indicate transmission of swollen shoot from scion to seedling stock, while all control buddings in the same area are healthy, and no other infected seedlings have been found anywhere on the station. Further confirmatory experiments will be done in cages as the possibility of transmission by sucking insects must be considered.

Entomological Investigations.—The Capsid bug breeding on cacao pods on Tafo station, and in cacao farms in the vicinity, hitherto recorded as No. 1239, has been confirmed by the Imperial Institute

of Entomology as *Bryocoropsis laticellis* Schum. Daily random collections made on a quarter-acre plot at Tafo station severely attacked by *Sahlbergella* spp. and *B. laticellis* showed that during July-September *S. theobroma* and *B. laticellis*, both of which breed and feed on pods and on seedling cocoa, tended to decrease in number, while the proportion of *S. singularis*, which is responsible for the major amount of damage to shoots of bearing trees increased during September. In the October-December period the total incidence increased latterly, but *B. laticellis* tended to fall off in numbers at the end of the period as fewer pods were available on which they were able to breed.

Observations have shown that *B. laticellis* does not normally breed on herbaceous shoots in the field, but it is probable that some damage is caused to shoots by the adults. The average length of life of the female adult insect was found to be 30 days, during which period the average number of eggs laid was 64.

Spraying.—Spraying of 70 acres of cacao on Tafo station has been carried out using a nicotine sulphate ("Black Leaf 40") solution made up as follows: water, 6 gall., hard soap, 2 lb., or soft soap 4 lb.; "Black Leaf 40," 1 pint. This stock solution was made up to 160 gallons for use in the field, 114 gallons per acre being used at an average cost of 10*s.* 2*d.* per acre. The incidence of *Sahlbergella* spp. on the station was considerably reduced. Experiments under laboratory conditions showed that provided effective cover was secured the solution used killed all stages of the insect other than the egg stage. Experiments with pyrethrum products and extracts of nicotine made by steeping local tobacco are in hand.

Fruits

Citrus

Dominica.—Mr. F. G. Harcourt, Agricultural Superintendent, states that during the half year ended December 31, 1939, trials previously reported upon were continued, and in spite of rather low rainfall, satisfactory progress is to be recorded.

Lime Breeding.—Selected hybrids have been back-crossed with the West Indian lime and sowings made of seeds obtained. These hybrids have so far not proved susceptible to withertip, but their fruits do not approximate the West Indiam lime sufficiently closely to warrant trial commercially.

Stock Trials for Limes.—Yields from trees on grapefruit stock continue to be greater than from trees on either sour orange or rough lemon. There are definite indications that the latter stock is very susceptible to gummosis and that the grapefruit stock is also susceptible but to a much less degree. The sour orange stock continues to show a high degree of resistance to the disease, and is the only stock extensively used by the Department for citrus propagation.

Grapefruit and Orange Varieties.—All varieties are growing well. Of the grapefruit varieties Marsh is the standard variety adopted by planters, and the pink-fleshed Foster is grown on a small scale to meet a limited demand in Canada. The Washington Navel is the chief orange grown and Valencia for the late market. Lamb's Summer, a variety introduced by this Department for trial, is now regarded as a promising late orange and is being planted on estates for commercial trial.

Government Fruit Farm.—Experiments in the application of lime and/or rock phosphate are being continued. This is a long term experiment, but it is observed that better increments of growth have attended the use of lime alone.

Plant Distribution.—Dry conditions rendered nursery work difficult, but by judicious watering and the use of mulches the demand for most economic plants was met. Budded citrus plants were chiefly propagated and approximately 11,000 distributed.

Lime Experiment Station.—Almost continuous rains in April adversely affected time of maturity and yield. Seedless limes, referred to in previous reports, gave a small first crop.

Top-working of Citrus Trees.—A satisfactory technique has now been evolved for converting citrus trees, except very old ones, to any desired variety.

FORESTRY

GENERAL

Nigeria.—The Chief Conservator of Forests has furnished the following report on research work conducted during the period July-December 1939.

Further Nigerian timbers were tested for their strength qualities; a graveyard test to compare 18 types of preservative treatment was laid down, and already yields significant results; additional preservative treatments are being examined.

Steam heating of the open tank for wood preservation has been installed to replace furnace heating. This installation facilitates temperature control and improves absorption results.

Investigations with "Dowicide" and "Santobrite" dips have been carried out with satisfactory results, bringing local white woods susceptible to stain into the match-board and box-wood class. Soap-making firms are particularly interested.

Preparations for the "experimental mile" of wooden sleepers are now under way. Logs of the ten common species to be included in the test have been supplied to the Ijora mill for conversion. The species selected are: Agboin (*Piptadenia africana*), Okan (*Cylicodiscus gabunensis*), Ohia (*Celtis* sp.), Agba (*Gossweilerodendron balsamiferum*), Obobonofua (*Guarea cedrata*), Okwen (*Brachystegia* sp.), Iroko (*Chlorophora excelsa*), Opepe (*Sarcocephalus diderrichii*), Ekki (*Lophira alata* var. *procera*), Afara (*Terminalia superba*).

The sleepers will be seasoned, impregnated and laid next year in two sections of the line.

The possibility of using *Musanga smithii* as a pulpwood and source of cellulose is being investigated. This species would be too bulky to stand transport overseas in the form of billets but might be compressed into bales for export. It has been found that under a pressure of less than a ton *Musanga* can be compressed to one-third of its bulk, into bales weighing 30-40 lb. per cubic foot. Very strong bands are required to hold it, as there is a considerable recovery when pressure is released. Rates of drying and the range of moisture content of the wood have been determined on an experimental scale.

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IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

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Versuche mit chemischen Mitteln zur Bekämpfung des Kartoffelkäfers. (*Leptinotarsa decemlineata* Say.) By K. Sellke. *Arb. Physiol. Angew. Ent. Berl.*, 1939, **6**, No. 2, 146-171. (*R.A.E.*, 1939, **27**, A, Pt. 12, 634.) Satisfactory control obtained with a dust containing pyrethrum mixed with derris.

OTHER INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

The " Acridifuge " Action of an Extract from the Leaves of *Melia azadarach*. By M. Volkonsky. *Indian For.*, 1940, **66**, No. 1, 53-58. (From *Arch. Inst. Pasteur. Alger.*) Repellant action for locusts is discussed.

Insecticide from the Leaves of the Castor Oil Plant. By A. G. H. Reimold. *Paper Ind.*, 1938, **20**, 308-309. (Abstract *Review No.* 57, *Scientific Sect., National Paint Varnish and Lacquer Assoc.*, Washington, D.C.)

Insecticidal Properties of Extract of Male Fern (*Aspidium filix-mas* (L.) S.W.). By F. Wilcoxon. A. Hartzell and Fredericka Wilcoxon. *Contrib. Boyce Thompson Inst.*, 1939, **11** (1), 1-4.

NOTE.—The reference in brackets *R.A.E.*, etc.—which appears after certain items of the bibliography indicates the part and page of the *Review of Applied Entomology* in which an abstract of the publication mentioned can be found.

BOOK REVIEWS

Books for review should be addressed to " The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

SOIL CONSERVATION. By Hugh Hammond Bennett. Pp. xvii + 993, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1939.) Price 40*s*.

Despite the number of excellent books on soil erosion and conservation which have been published in recent years, the present volume is in no sense redundant, being a welcome addition to the literature. In his wide and comprehensive treatment of the subject the author has not only provided a valuable reference work, but an account of such interest that it should be a real contribution in

bringing home to the public the urgency of this problem. The fact that much of the subject matter is concerned directly with soil conservation in the United States does not materially reduce its general application.

The text is divided into two main parts: Part 1, The Problem—Soil Erosion; Part 2, The Means of Tackling It—Soil Conservation. The first part, which forms nearly one-third of the book, describes the various types of erosion, their extent and the manner in which they occur, and includes an interesting chapter on the influence of soil erosion on civilisation, past and present. Part 2 gives details of the various methods of conservation in use, and contains accounts of actual problems and soil conservation programmes which are being carried out in different areas of the United States. The discussion of such general programmes is made all the more valuable in view of the author's close association with the United States Soil Conservation Service. The numerous excellent illustrations and diagrams included in the text form a further valuable feature.

GROWING PLANTS IN NUTRIENT SOLUTIONS. By Wayne I. Turner and Victor M. Henry. Pp. xiii + 154, 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1939.) Price 18*s*.

While primarily of interest to the intending grower this book combines the practical information with the elements of theory, thus widening the general scope and putting the whole on a more scientific basis.

Details are given of equipment required and techniques of culture in nutrient solutions with particulars of the methods of making up the solutions and quantities of materials used. The chapter on the diagnosis of deficiency symptoms should be a useful feature.

The book is very well illustrated and includes a short bibliography and a detailed index.

FIELD TRIALS: THEIR LAY-OUT AND STATISTICAL ANALYSIS. By John Wishart, M.A., D.Sc. Pp. 36, 9¾ × 7¼. (Cambridge: Imperial Bureau of Plant Breeding and Genetics, 1940.) Price 2*s*. 6*d*.

The object of this publication is to provide an elementary account of the methods employed in the lay-out of field trials and the interpretation of the results. It deals with the measurement of experimental error and describes the methods of randomised blocks and the Latin square, as well as multiple factor experiments, split-plot experiments and experiments with large numbers of varieties. The book serves as an excellent introduction to the more elaborate treatises on the subject.

TECHNIQUE OF GRASSLAND EXPERIMENTATION IN SCANDINAVIA AND FINLAND. *Herbage Publication Series Bulletin* 28. Pp. 52, $9\frac{3}{4} \times 7\frac{1}{4}$. (Aberystwyth, Wales: Imperial Bureau of Pastures and Forage Crops, 1940.) Price 2*s*. 6*d*.

THE BREEDING OF HERBAGE PLANTS IN SCANDINAVIA AND FINLAND. *Imperial Agricultural Bureaux Joint Publication No.* 3. Pp. 123, $9\frac{3}{4} \times 7\frac{1}{4}$. (London: Imperial Agricultural Bureaux, 1940.) Price 4*s*.

The Imperial Bureau of Pastures and Forage Crops, Aberystwyth, is performing a most useful task in bringing to the notice of Empire agriculturists the results and experience of workers in other countries. The two publications now under notice comprise a series of papers contributed by authorities in Scandinavia and Finland, preceded by general summaries of the matter provided.

To the Bulletin on Grassland Experimentation G. Giöbel and K. Lundblad contribute respectively papers on the technique employed in experiments of the Swedish Grassland and Peat Association, and on methods for botanical analyses. B. Sakshang deals with methods of pasture experiments in Norway, and H. Foss with meadow experiments in that country. As regards Denmark, methods of grassland analysis are dealt with by H. Bögh, and the technique of experiments with strains and seeds mixtures by H. Hansen. C. A. G. Charpentier writes on methods used in pasture experiments in Finland.

The Imperial Bureau of Plant Breeding and Genetics, Cambridge, has collaborated with the Imperial Bureau of Pastures and Forage Crops in producing the publication on the Breeding of Herbage Plants in Scandinavia and Finland. Subjects concerned with Sweden comprise herbage plant breeding by G. Nilsson-Leissner and F. Nilsson, the application of cytology to herbage plant breeding by E. Åkerberg, and lucerne breeding by R. Torssell. H. N. Frandsen has two papers, on improvement of herbage plants in Denmark and some breeding experiments with timothy. H. Wexelsen, of Norway, writes on selection and inbreeding in red clover and timothy, and O. Pohjakallio on red clover breeding in Finland.

VEGETATIVE PROPAGATION OF TROPICAL AND SUB-TROPICAL PLANTATION CROPS. Compiled by G. St. Clair Feilden, B.A. Drawings of propagation methods and accompanying descriptions by R. J. Garner, N.D.H., Dip. Hort. Sci. *Imperial Bureau of Horticulture and Plantation Crops, Technical Communication No.* 13. Pp. 99, $9\frac{3}{4} \times 7\frac{1}{4}$. (East Malling, Kent: Imperial Bureau of Horticulture and Plantation Crops, 1940.) Price 3*s*. 6*d*.

In 1936 the Imperial Bureau of Fruit Production, as it was then called, issued a publication (*Technical Communication* No. 7) dealing with the vegetative propagation of tropical and sub-tropical fruits. The present work covers practically every other tropical

or sub-tropical perennial crop. All the usual "plantation" crops are dealt with, such as tea, coffee, cocoa, rubber, cinchona, sugar, sisal, spices, etc., as well as some drug plants, root crops, essential oils, cover crops and a few minor fruits or nuts, not included in the earlier publication. A useful and very well illustrated outline of the various methods of vegetative propagation is first given, and then follows a digest of all available information concerning the propagation of the various crops, which are arranged alphabetically under their botanical names. The references to the literature cited are given under each heading.

The publication is more than a mere guide to the literature, since in most cases sufficient information is given to enable the practical man to proceed without having to refer to the original. It should prove of special value to those concerned with the introduction of new crops into Empire countries.

THE CONTROL OF WEEDS. Edited by R. O. Whyte. *Herbage Publication Series Bulletin* 27. Pp. 168, 9¾ × 7¼. (Aberystwyth, Wales: Imperial Bureau of Pastures and Forage Crops, 1940.) Price 7*s*. 6*d*.

This volume is a symposium on the prevention and eradication of weeds on agricultural land by cultural, chemical and biological means. It includes papers by different authors on weed problems and control in Canada, the United States, Germany, Australia and New Zealand, on the principles of chemical weed control, on weed control in turf, and on the biological control of prickly-pear in Australia. There are also three papers dealing specifically with noxious weeds, viz., chemical analyses as an aid to classification of poisonous plants, biological control of noxious weeds in New Zealand and the most important poisonous plants of South Africa. The papers illustrate the very wide range of research that is being carried out on weed control in different countries and will be of great value to those engaged on similar problems elsewhere.

THE LAW OF FOOD AND DRUGS. By G. M. Butts. Pp. lxxii + 603, 8½ × 5¼. (London: The Solicitors' Law Stationery Society, Ltd., 1940.) Price 35*s*.

This volume has been compiled to give a detailed commentary on the Food and Drugs Act, 1938, and in addition to present some account of other matters of interest to dealers in, and consumers of, foodstuffs. It is, however, pointed out that the whole book, with the exception of Appendix V, was completed before the outbreak of war, and the reader is warned that the text should be read subject to any more recent measures brought into being by reason of the present emergency.

Part I of the text deals with the scope of the Act, its application, extent and administration; legal proceedings; definitions and general provisions relating to food; civil liability and other statutory

provisions. Part II covers the general provisions pertaining to food and drugs; provisions regarding milk, dairies and artificial cream; provisions as to other kinds of foods; provisions as to importation; conditions governing markets, slaughter-houses and cold air stores, and also general and miscellaneous information. Appendices give sections of the Public Health Act, 1936, incorporated with the Food and Drugs Act, 1938, and other statutes; orders and regulations pertaining to milk and articles other than milk, and also regulations governing Public Analysts. Appendix V covers the emergency provisions up to, and including, regulations published on January 25, 1940.

BREWING. SCIENCE AND PRACTICE. By H. Lloyd Hind, B.Sc., F.I.C., F.R.M.S. Volume II. Brewing Processes. Pp. xiv + 507-1020, 9¾ × 6¼. (London: Chapman & Hall, Ltd., 1940.) Price 56*s*.

When the first volume of this treatise, dealing with Brewing Materials, was published in 1938 (see this BULLETIN, 1939, **37**, 241), it was intended to complete the work in two volumes, but the amount of available material on the subject of Brewing Processes proved to be so extensive that the author found it necessary to plan still a third volume to cover Bottling, Brewing Cleaning, By-products and Analysis. This is in an advanced state of preparation with the help of a well-known specialist.

The present volume deals with every aspect of the various processes involved in brewing, including equipment, mashing, wort boiling, fermentation and racking and cellar management. These sections are well illustrated with photographs of plant and equipment. Then follow sections on the microbiology and biochemistry of fermentation, including accounts of the various yeasts and moulds concerned in fermentation, and also bacteria, the last-named being specially contributed by Dr. J. L. Shimwell. Here again, the illustrations, comprising numerous microphotographs of the different organisms, contribute greatly to the value of the work.

Although the pagination runs on from Volume I, the book is complete in itself, with its own author and subject indexes.

This volume, like its predecessor, will be found indispensable to all interested in any degree in the brewing industry.

SULPHATED OILS AND ALLIED PRODUCTS. Their Chemistry and Analysis. By Donald Burton, M.B.E., D.Sc., F.I.C., and George F. Robertshaw, A.M.S.T., A.I.C. Pp. iv + 163, 9½ × 6. (London: A. Harvey, 1939.) Price 12*s*. 6*d*.

This book is an outcome of the efforts the authors began over ten years ago to suggest to the International Society of Leather Trades' Chemists suitable methods for analysing sulphated oils. For this purpose a critical examination was made of the methods available when it was found that these had very serious limitations

owing to the complicated constitution of these substances and the incomplete knowledge of this branch of chemistry. A scheme of analysis was drawn up in which methods were described together with notes on the interpretation of the results (see *J. Soc. Leather Tr. Chem.*, 1931, **15**, 308; 1933, **17**, 3 and 293). This scheme has been adopted by the International Commission for the Study of Fats. In response to requests for a revised edition the present volume has been published.

After an opening chapter giving a historical survey of the subject, the various raw materials used in the preparation of sulphated oils are described together with short accounts of methods of sulphation. Then follows a chapter on the constitution of the oils in question and on the chemistry involved in their preparation. The remainder (and the bulk) of the book is devoted to methods for the analysis of sulphated oils and their allied products, e.g. sulphated fatty alcohols and petroleum sulphonic acids. Full accounts are given of the analytical methods which have been proposed for the determination of each of the various characteristics and the separation of a sulphated oil into its main groups is described in detail. Critical observations are made on the value and accuracy of these methods, and notes are given on the interpretation of the results obtained.

The authors have brought together in this book all the data at present available on the subject. It should be of great value to those analysts and technicians who have to deal with sulphated oils. The information contained therein, besides giving guidance as to the most suitable analytical methods indicates the direction in which further research is required in order that better chemical control of many of these sulphated products may be obtained.

THE CHEMISTRY AND TOXICOLOGY OF INSECTICIDES. By Harold H. Shepard, Ph.D. Pp. iii + 383, $10\frac{3}{4} \times 8\frac{1}{4}$. (Minneapolis, Minn., U.S.A.: Burgess Publishing Company, 1939.) Price $4.00.

One of the troubles that confront those whose work lies in the study or preparation of insecticides is the time taken up in searching for reliable information on the subject. The demand for a comprehensive and up-to-date list of references has now been met by means of bibliography such as is published regularly in this BULLETIN, but up to the present there are extremely few books of reference available to those who wish to obtain information without reading through a large number of original papers. This volume is, therefore, a welcome addition to the literature on insecticides and fumigants.

Although this work was written primarily for the use of those engaged in entomology, it would appear to be equally useful to the biologist, analytical chemist and insecticide manufacturer, since it includes the important chemical, physical and toxicological facts and theories relative to insecticides. The text includes sections on

the quantitative toxicology of insecticides, arsenical and non-arsenical inorganic stomach poisons, sulphur and copper contact insecticides, plant insecticides, synthetics, insecticide adjuvants and insect fumigants. One feature that is especially welcome is the collation of information under the various insecticides of their toxicity not only towards insect pests but also towards animals and human beings. Numerous references to original papers and a satisfactory index add to the use of an already comprehensive and carefully compiled volume.

THE MANUFACTURE OF PULP AND PAPER. Prepared under the Direction of the Joint Textbook Committee of the Paper Industry of the United States and Canada. Volume V. Papermaking Machines; Handmade Papers; Paper Finishing; Coated Papers; Paper Testing; Papermaking Details. Third Edition. Pp. xiii + 748, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1939.) Price 36*s*.

The various sections of this volume, like those of the earlier ones, have been prepared by experts in the subject dealt with. The reliability of the information furnished is therefore unquestioned. During the ten years which have elapsed since the last edition appeared great advances have been made in the technique of papermaking, and this is reflected in the many changes which have been made in the book. The section on papermaking machines, which is by far the largest in the book (406 pp.) now embodies descriptions of new headbox designs, a new method of installing the wire, a new press part, a new electric drive, an additional chapter on insulating boards, and new designs of cylinder machines. Extensive changes have been made in the section on handmade papers, and in the last section of the book, headed " Papermaking Details," in which the various grades of paper and boards are defined and a summary given of the principal points to be observed in their manufacture. The sections on coated papers and paper testing have been re-written. The last-named section deals not only with physical and chemical tests, but also contains an outline of the methods employed in the microscopical examination of paper.

This work will not only prove of great service to the papermaking student, for whom it is specifically prepared, but also serves as a valuable book of reference to all engaged in the industry.

A HANDBOOK OF EMPIRE TIMBERS.—Edited by H. A. Cox, M.A. Pp. vii + 214, 9½ × 6¼. Department of Scientific and Industrial Research, Forest Products Research. (London: His Majesty's Stationery Office, 1939.) Price 3*s*. 6*d*.

The publication of this volume marks a further stage in the evolution of an authoritative handbook on the timbers of Empire origin marketed in this country. The first step in this direction was the issue in 1928 of the Descriptive List of Some Empire Timbers recommended by the Imperial Institute Advisory Com-

mittee on Timbers which formed the basis of the Handbook of Empire Timbers published by the Empire Marketing Board in 1932. Since that year much new information has become available regarding the increasing number of Empire woods commercially established in the United Kingdom, and a demand for an up-to-date account of the timbers has resulted in the welcome appearance of the present handbook, which incorporates the results of much important work carried out at the Forest Products Research Laboratory, Princes Risborough.

The Empire Marketing Board's handbook dealt with about 60 timbers, including a number produced in this country. The present handbook reverts to the plan of the Imperial Institute's Descriptive List and confines itself to overseas timbers, both hardwoods and softwoods; and, as also in the List, includes tables of mechanical (strength) properties of the woods, based to a considerable extent upon researches at Princes Risborough, which were absent from the Marketing Board's publication. Some 79 hardwoods and 17 softwoods are described under the two classes in alphabetical order of their trade names as published in the Empire Forestry Handbook (1938); practically all Empire woods met with in timber merchants' yards are included. The descriptive treatment is familiar: a paragraph on other trade names used in this country is followed by sections on the tree, characters of the timber, seasoning, wood bending and mechanical properties, durability, liability to insect attack, preservative treatment, working qualities, uses, and supplies. The amount of information available under these heads naturally varies with the timber concerned, for much still remains to be done in utilisation research. The treatment is usually brief but records the salient points involved.

The main body of the book is preceded by a concise introduction which discusses the significance attaching to the values recorded for the weights, shrinkage, bending properties and strength properties of the woods described, and also comments on susceptibility to attack by fungi, insects and marine borers, permeability to preservatives, and wood-working qualities. This useful section explains the data set out in the appendixes and enables a comparison to be made between the different woods. The Appendixes comprise a series of kiln drying schedules, the tables of mechanical strengths referred to above and specifications for the teeth of circular saws.

Such a work is of obvious utility, and the book should be available in every timber merchant's office and in the hands of all users of timber. A few minor points may be noticed. A classification "by countries" of the timbers described would be useful; the Empire countries concerned with supplies might have been specifically mentioned in the cases of West Indian satin wood and lignum vitae; and the inclusion of cocus or "Jamaica ebony" (*Brya ebenus*) would have been useful, as would also a fuller account of the applications and possibilities of the South African boxwoods.

A HANDBOOK OF HOME-GROWN TIMBERS. Second Edition. Pp. vi + 87, 9½ × 6¼. Department of Scientific and Industrial Research, Forest Products Research. (London: His Majesty's Stationery Office, 1939.) Price 2s.

As revised and expanded this handbook deals with 26 hardwoods and 9 softwoods. The reader may at first sight be surprised at the number of utilisable hardwoods grown in this country, but the list comprises alder, ash, beech, birch (2 species), cherry, horse chestnut, sweet-chestnut, elm (3 species), hornbeam, lime, oak (2 species), plane, poplar (5 species), sycamore, walnut and willow (3 species); and among softwoods Douglas fir and Silver fir, European and Japanese larch, Corsican pine and Scots pine, Norway spruce and Sitka spruce and yew. The additional species dealt with in the new edition are cherry, plane, Japanese larch and yew.

The text is arranged on similar lines to that of the Handbook of Empire Timbers referred to on page 214 of this issue. Three appendixes are concerned, respectively, with kiln schedules, mechanical (strength) values of the timbers, and specifications for the teeth of circular saws; while the enlarged introduction is, *mutatis mutandis*, practically identical with that for the volume on Empire timbers and serves the same useful purpose. The utility of this revised handbook needs no emphasis.

CHEMICALS OF COMMERCE. By Foster Dee Snell, Ph.D., and Cornelia T. Snell, Ph.D. Pp. viii + 542, 8½ × 5½. (London: Chapman & Hall, Ltd., 1940.) Price 28s.

A work which covers a very large number of commodities of very diverse chemical composition and is not compiled by a group of technical experts in the various subjects is always open to the danger that the subject matter may contain much that is misleading or even erroneous. This volume is much less guilty of this fault than is usual, and it may be said that it fulfils its claim to be a source of information on the composition of actual commercial products; it is not intended to be a chemical dictionary which gives a brief description of all chemical compounds. The main fault of this book as far as this country is concerned is that having been written for use in the United States of America, reference to the standards ruling there do not necessarily apply here. In spite of this the range of products referred to in the text which include inorganic acids, bases and compounds; petroleum hydrocarbons and hydrocarbons other than those from petroleum; alcohols and phenols; organic acids, esters, aldehydes and amines, fats and waxes, organic dyes; natural and derived plant products, ensures the value of this volume as a quick source of summarised information concerning commercial chemical products.

MINERAL RESOURCES

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from Reports made to the Dominions, Indian and Colonial Governments

CORAL AS A BUILDING MATERIAL IN BRITISH HONDURAS

THE provision of cheap and durable building units of brick, stone, concrete, etc., is a matter of considerable importance in many of the Colonies, and the ingenuity and resource of local officials is often exercised in a search for suitable raw material. The expense of imported Portland cement often renders its employment impracticable, and the cost of plant for the local manufacture of this product, even where suitable clay and limestone are available, is usually prohibitive. It is also frequently impossible to undertake the manufacture of ordinary bricks.

In British Honduras the problem has been under consideration for some time, and the local Public Works Department have carried out experiments, apparently with considerable success, on the use of coral and accompanying mud dredged from the bed of the harbour at Belize. This material, when mixed with Portland cement, gives a product which has proved suitable for building purposes. In view of the high cost of the cement, however, it was thought that the material might be used without this admixture, and a quantity was sent to the Imperial Institute in order that, if possible, a suitable form of treatment might be devised. Such a process is described in the following summary of a report which has been sent to British Honduras, and as far as can be judged, subject to local weathering trials proving satisfactory, the product appears likely to meet local requirements.

The sample sent for examination, known locally as "pipe-shank," weighed about 1 ton, and consisted of a branched coral, together with a quantity of greyish mud. Much sea-water was

present, and it was understood that the material was representative of that obtainable from the harbour bed.

A number of blocks, prepared locally from mixtures of pipeshank and Portland cement, were also forwarded for their crushing strengths to be determined.

The results of the examination of these materials are detailed below:

Chemical Analyses

Chemical analyses of the pipeshank were made on the sample as received after removing the excess water (A), and also on that portion of the sample passing a 1/20 in.-mesh sieve (B), both analyses being carried out on the air-dried material. The results are tabulated below:

TABLE I

		A As received. (*per cent.*)	B Passing 1/20 in. mesh. (*per cent.*)
Silica	SiO_2	3·86	5·21
Ferric oxide	Fe_2O_3	0·58	0·70
Ferrous oxide	FeO	0·14	0·29
Alumina	Al_2O_3	1·39	1·53
Titanium dioxide	TiO_2	0·05	0·10
Lime	CaO	47·83	47·33
Magnesia	MgO	1·55	1·23
Sulphur (incl. SO_3)	S	0·15	0·21
Loss on ignition		43·50	42·24
		99·05	98·84

The grey coloured, finely-divided material is thus shown to be essentially of the same composition as the main bulk.

Preliminary tests, involving trials with untreated pipeshank

It had been suggested that the pipeshank might possess hardening properties on exposure to the air, and the first stage of the practical trials consisted of experimental work on this aspect of the possible utilisation of the raw material.

The tests were carried out in the following manner:

A quantity of the moist sample, which had previously been drained free from excess sea water, was placed in steel cube moulds measuring 6 in. × 6 in. × 6 in. The filled moulds were gently vibrated in order to consolidate the pipeshank and free it from entrapped air; the surfaces of the cubes were levelled, and the moulds were then transferred to a room in which the temperature was maintained at 85° to 90° F. at 80 per cent. relative humidity, conditions which it was considered would approximate to those prevailing in British Honduras. At the end of 7 days the cubes were taken from the moulds and then stored for periods of 21 days and 3 months under the same conditions as before. The results obtained on crushing these cubes were as follows:

TABLE II

Untreated Pipeshank—Crushing strength in lb. per sq. in.

(Rate of loading 1,000 lb. per sq. in. per min.)

	After 28 days.	*After 3 months.*
1	73	93
2	91	73
3	80	83
4	77	70
Mean	80	80

A series of cubes measuring approximately 3 in. × 3 in. × 3 in. was also made from moist, drained pipeshank, previously ground to pass a ¼ in.-mesh sieve. The cubes were made and matured for a total of 28 days under conditions similar to those outlined above, and yielded the following results on crushing :

TABLE III

Pipeshank previously crushed to ¼ in. mesh—Crushing strength, after 28 days

(Rate of loading 1,000 lb. per sq. in. per min.)

1	248 lb. per sq. in.
2	220 ,, ,, ,,
3	236 ,, ,, ,,
4	254 ,, ,, ,,
Mean	240 ,, ,, ,,

The greater strength of the crushed pipeshank, recorded in Table III, is probably due to the larger proportion of fine material present and the consequent better consolidation.

Further test cubes made from the uncrushed and crushed material referred to above were aged for a total of 28 days in the same way as before and then submerged in water. All of them slumped badly within 30 minutes and it was obvious that no hardening had taken place during the ageing period. Other test pieces made from the uncrushed material, and aged for three months, also slumped badly within 30 minutes of being placed in water.

These results show that the pipeshank possesses no hardening properties, and would be of no value in the crude state as a building material.

Experiments with mixtures of pipeshank and slaked lime

In order to see whether a more durable building block could be obtained from the material, a series of experimental tests were made with mixtures of pipeshank and slaked lime prepared from the pipeshank. The lime was prepared in the following manner: A quantity of the pipeshank was placed in a conical heap over a perforated grating and allowed to drain for 6 hours, thus removing most of the sea water. The drained material was spread out on large iron trays to a depth of about 4 in., dried at a temperature of about 80° C., and finally sieved on a ½ in.-mesh sieve. The material remaining on the sieve, which amounted to about 50 per

cent. by weight of the dried pipeshank, was then calcined for 4 hours at 1,000° C. (a temperature which would be obtainable in kilns fired by wood fuel), and the cooled lime slaked to a putty. After the removal of the excess water the product was dried.

A series of test pieces was then made from mixtures of the slaked lime with that portion of the dried pipeshank, which had passed a ½ in.-mesh sieve, the latter having first been crushed to pass a ¼ in.-mesh sieve. The lime and crushed pipeshank were first mixed dry for about 3 minutes, and then for a further period of about 4 minutes with the addition of water, the operation being carried out by hand trowelling. As it had been previously ascertained that mechanically-pressed blocks would be preferred in the Colony to hand-made units, all mixtures were moulded into cubes at a pressure of 4,000 lb. per sq. in., which approximates to that normally used in the manufacture of sand-lime bricks. After removal from the moulds the cubes were stored in an atmosphere maintained at the same temperature and humidity as in the preliminary experiments. The results obtained from this series of experiments after various periods of ageing were as follows:

TABLE IV

Crushing strength in lb. per sq. in. of machine-moulded blocks made from slaked lime and pipeshank

(Rate of loading, 1000 lb. per sq. in. per min.)

Ageing period.		Mixture (*parts by weight*).			
		Lime 1 : Pipeshank 3.	Lime 1 : Pipeshank 5.	Lime 1 : Pipeshank 7.	Lime 1 : Pipeshank 10.
28 days . .	1	1420	1299	1266	1128
	2	1245	1295	1182	1153
	3	1270	1134	1309	1114
	Mean	1312	1243	1252	1132
3 months .	1	1353	1403	1289	1163
	2	1282	1316	1270	1134
	3	1318	1384	1232	1120
	Mean	1318	1368	1264	1139

The strengths recorded in Table IV are much superior to those given by the crude pipeshank, but are only about half those of common bricks normally used for building purposes.

Pressure hardening of blocks made from slaked lime and pipeshank

It was considered probable that an improvement on the strengths recorded in Table IV could be obtained by hardening the blocks in an atmosphere of carbon dioxide.

Preliminary investigations proved that hardening in carbon dioxide at atmospheric pressure was unsuccessful, such conditions producing an impermeable crust on the cubes. This case hardening

gave a temporary increased crushing resistance, but a decided falling off in the strength of the cubes was found to take place when they were subsequently aged in air under the same conditions as before. In some instances the strength of the blocks fell below that previously recorded for similar blocks aged solely in air, and it is difficult to suggest a satisfactory explanation for this phenomenon, which was observed in repeated tests.

Further experiments proved that artificial curing could be successfully carried out if the cubes were subjected to the action of carbon dioxide under slight pressure.

Tests to determine the best conditions showed that a pressure of 20 lb. per sq. in. maintained for 10 hours, yielded blocks of maximum strength.

It was observed that test pieces cured for a period in air at atmospheric pressure previous to curing with carbon dioxide at 20 lb. per sq. in. pressure had a higher crushing resistance than similar cubes cured under pressure immediately after moulding.

The results of tests carried out on cubes cured by both methods and subsequently aged in air as before for different periods are shown in Table V below.

TABLE V

Crushing strength of Pipeshank—Lime mixtures after curing in CO_2 at 20 lb. per sq. in. pressure

(Results expressed as lb. per sq. in.)

Mixture. (Parts by weight)		Specimens placed in hardening chamber 30 minutes after moulding. Strength at specified periods after removal from hardening chamber.				Specimens first stored for 2 days in air at a temperature of 85-90°F, previous to hardening under pressure. Strength at specified periods after removal from hardening chamber.			
		0 days.	3 days.	7 days.	28 days.	0 days.	3 days.	7 days.	28 days.
3 parts Pipeshank	1	2002	2175	2304	2738	2383	2450	2559	2801
1 part Lime	2	2099	2006	2410	2645	2376	2373	2581	2751
	3	1971	2143	2387	2680	2190	2408	2642	2796
	4	1960	2125	2452	2701	2234	2349	2527	2779
	Mean	2008	2112	2388	2691	2296	2395	2577	2782
5 parts Pipeshank	1	1230	1256	1423	1850	1329	1560	1755	2330
1 part Lime	2	1183	1269	1471	1887	1297	1595	1863	2374
	3	1172	1281	1520	1990	1343	1620	1842	2298
	4	1202	1250	1443	2061	1374	1641	1821	2272
	Mean	1197	1264	1464	1947	1336	1604	1820	2319
7 parts Pipeshank	1	980	1077	1189	1452	1098	1318	1486	1879
1 part Lime	2	1018	1051	1136	1621	1144	1270	1450	1946
	3	965	1037	1164	1562	1021	1356	1424	1891
	4	943	1040	1177	1501	1136	1332	1537	1863
	Mean	977	1051	1167	1534	1100	1319	1474	1895
10 parts Pipeshank	1	768	855	1034	1480	961	1014	1270	1783
1 part Lime	2	736	869	1068	1404	905	1109	1365	1808
	3	700	880	1009	1379	987	1101	1200	1705
	4	758	931	1122	1324	926	994	1298	1724
	Mean	741	884	1058	1397	945	1030	1283	1766

The following crushing strengths (lb. per sq. in.) of stone and brick, recorded in *Mechanical Testing*, by Batson and Hyde, 1931, are appended for comparison: Limestone, 2,000-9,100; Fletton bricks, 2,600-3,900; Common stock bricks, 1,250-1,900.

Porosity and Water Absorption.—Similar specimens were tested for porosity and water absorption with the results shown in Table VI.

As it was known that subsequent ageing of the pressure-cured test pieces produced an increase in strength, it was considered justifiable to limit the number of porosity determinations to one set of blocks from each series of mixtures, aged for the same period. It can probably be assumed that as the blocks gained in strength they would tend to decrease in porosity; the figures recorded may reasonably be regarded as roughly equivalent to those that would be obtained from blocks used for building within two or three days of the conclusion of the pressure-hardening process.

The results given in each case are the mean values obtained from four determinations.

TABLE VI

Porosity, water absorption and apparent specific gravity of pressure-moulded Pipeshank-Lime mixtures after curing in carbon dioxide at 20 lb. per sq. in. pressure

(Specimens first stored in air for 3 days after removal from hardening chamber.)

Mixture. (*Parts by weight*)	Porosity. (*Per cent.*)	Water absorption. (*Per cent.*)	Apparent specific gravity.	Weight per cubic foot. (*Lb.*)
3 Pipeshank : 1 lime	30·2	16·2	1·75	109
5 Pipeshank : 1 lime	30·7	17·0	1·74	109
7 Pipeshank : 1 lime	30·9	17·4	1·74	109
10 Pipeshank : 1 lime . . .	31·5	18·2	1·74	109

The porosity recorded in this table is the volume of the pores expressed as a percentage of the volume of the whole piece.

The following figures are recorded by Batson and Hyde as being average values for the water absorption of ordinary bricks:

Common firsts . . .	12-18 per cent.
Common	Over 18 per cent.

Conclusions and Recommendations

The results of the experiments outlined above show that the crude pipeshank possesses no hardening properties, but that after appropriate treatment it is likely to prove a useful local building material. In view of local conditions, such as the ready availability of the material, the high cost of imported cement, and the cheapness of wood fuel and local labour, it appears probable that the process which has been devised at the Imperial Institute for its utilisation would be practicable and economical.

The plant necessary for the manufacture of bricks or other building units on the lines described in this report, and working

more or less continuously, would include the following: (1) a rotary lime kiln, or alternatively two stationary kilns, (2) a brick press similar to that used for the pressing of sand-lime bricks, (3) a gas compressor, (4) a hardening chamber.

It is suggested that a rough outline of an economical method of operating the plant would be as follows:

The freshly-dredged pipeshank would be stacked in heaps and allowed to drain. Stacking the material on suitably supported perforated iron plates would probably be the best method of carrying out this operation, but it is likely that a satisfactory separation of the greater part of the sea water could be effected by piling the pipeshank in cone-shaped heaps, and after allowing it to drain, using only the upper part of the heap, leaving the remainder to serve as the base of the next heap to be constructed. The drained pipeshank would then be transferred to a hot-floor dryer heated by waste gases from the lime kilns. This method of drying would entail no fuel costs for heating the dryer, which would also act as a waste kiln gas cooler and scrubber before passing the gases to the compressor.

The sieving, grinding, mixing and moulding plant would be arranged in close proximity to the dryer in order to avoid unnecessary transport of the raw materials. The freshly-made bricks could be transferred to the hardening chamber immediately after moulding or if preferred, allowed to dry partially and age in air for a few days. The carbon dioxide required for the hardening chamber would be obtained from the cool end of the drying plant and the gas maintained at the correct pressure by means of a simple gas compressor.

It is probable that one of the weaker mixtures of lime and pipeshank described in this report would yield bricks of sufficient strength for most of the single-storey building work contemplated.

In this case the excess lime produced could be used for agricultural work or for the production of good-quality fat lime putty for plastering. Much of the lime would, however, be needed for the preparation of lime mortar for the laying of the bricks.

A number of specimens prepared by pressure hardening in carbon dioxide were forwarded to British Honduras with the report, and it was suggested that in order to ascertain their behaviour under local weathering conditions, they should be exposed in the open air for a period of at least six months.

Crushing tests on building blocks sent for examination

A number of blocks made locally from mixtures of pipeshank and Portland cement were also tested for crushing strength and water absorption.

The percentage water absorption was first determined in the usual manner. The results obtained are tabulated in Table VII together with the figures for crushing strength. When preparing

the blocks for the crushing tests, irregularities in shape were compensated for by coating two opposite faces of the cubes with plaster of Paris. More accurate figures would have been obtained had it been possible to grind two plane parallel faces on the specimens and to dispense with plaster bedding, but no test piece was entirely free from loosely imbedded pieces of coral, which would have been further loosened by such grinding.

TABLE VII

Crushing strength and water absorption of building blocks prepared in British Honduras

Specimen number.	Crushing strength (*Lb. per sq. in.*)	Water absorption (*Per cent.*)
1 . .	882	58·9
2 . .	231	47·5
3 . .	245	49·4
4 . .	254	36·1
5 . .	221	36·6
6 . .	579	37·5
7 . .	677	24·1
8 . .	331	47·4

It will be seen, on comparison with the results recorded in Tables IV and V, that the process suggested by the Imperial Institute gives a much stronger product than that obtained locally by mixing the material with Portland cement.

PROGRESS IN COLONIAL MINERAL INDUSTRY

Comprising periodic statements on mining and geological activities received from Government Technical Departments overseas.

BECHUANALAND

The following report has been received from the Chief Mining Commissioner showing the amounts of gold and silver produced in the Protectorate during the three months ended November 30, 1939, and also during the three months ended February 29, 1940.

Mineral.	September 1, 1939 to November 30, 1939.		December 1, 1939 to February 29, 1940.	
	Amount. (*Troy oz.*)	Value.	Amount. (*Troy oz.*)	Value.
Gold—bullion .	5,959·06	£31,173 3*s.* 7*d.*	6,754·15	£33,019 6*s.* 8*d.*
„ fine .	4,218·74		4,391·44	
Silver . .	250·15	£1 2*s.* 2*d.**	259·48	£18 11*s.* 8*d.*

* *Full valuation figures not yet realised.*

The higher production of gold for the three months ended February 29, 1940, is due to the fact that the output of the larger mines, the Monarch, Phoenix, Jim's Luck and Map, was very much greater during this period than during that ended November

30, 1939. The smaller mines showed a decreased production during the latter period.

No new mineral discoveries were made in the Protectorate during the full six months, nor were any new mining developments initiated.

BRUNEI

According to information supplied by the British Resident, the production of oil in the last quarter of 1939 amounted to 200,576·35 tons. This represents the net production, after deducting water run off and pumping losses between field and refinery.

CYPRUS

The Inspector of Mines has submitted the following data regarding mineral production during the first quarter of 1940.

There was an increase in the quantity of cupreous pyrites exported during the quarter; 42,724 tons having been exported as compared with 33,699 tons for the previous quarter.

No cupreous concentrates were exported owing to the difficulties experienced in finding a market for this product since the outbreak of war.

As compared with the previous quarter the tonnage of asbestos exported increased from 1,320 tons to 1,952 tons. It is expected that the Amiandos asbestos mines will operate to full capacity during the current year.

There was a marked decrease in the tonnage of terra umbra exported.

No chrome ore was exported during the period under review.

MINERAL PRODUCTION AND EXPORTS, JANUARY-MARCH 1940

	Production. Tons.	Exports. Tons.
Cupreous pyrites (dry weight)		
Skouriotissa Mine	1,233	5,525
Mavrovouni Mine	143,837	33,215
Lymni Mine	25	—
Kalavaso Mine	—	3,825
Akoliou Mine	710	159
Cupreous concentrates (dry weight)		
Mavrovouni Mine	—	—
Chrome ore (Cyprus Chrome Co., Ltd.)		
Mined	1,089	—
Treated	4,078	—
Asbestos (Tunnel Asbestos Cement Co., Ltd.)		
Rock mined	6,506	—
Rock treated	433	—
Asbestos fibre produced	—	1,952
		Troy oz. fine.
Gold (contained in ores, concentrates and precipitates)	—	4,055*
Silver (contained in ores, concentrates and precipitates)	—	21,296*
Other minerals exported		*Tons.*
Gypsum, calcined	—	195
Gypsum, raw	—	178
Terra umbra	—	1,002
Terra verte	—	20

* *Based on provisional returns*

GOLD COAST

The following statement showing the mineral exports of the Gold Coast during 1939 has been supplied by the Geological Survey Department.

	Exports.	*Value.*
Gold	795,207 *fine oz.*	£6,165,873
Diamonds	1,087,651 *carats*	£464,438
Manganese ore	336,312 *dry tons*	£789,606

MALAY STATES (FEDERATED)

The following data for the last quarter of 1939 have been compiled from returns furnished by the Chief Inspector of Mines.

PRODUCTION OF TIN-ORE
(October to December 1939)

State.	Metal content (*Long tons.*)	Value (£.)
Perak	11,841	2,744,101
Selangor	6,674	1,542,451
Negri Sembilan	567	131,722
Pahang	988	227,670
Total	20,070	4,645,944

Other minerals produced during the quarter were: gold, 11,863 troy oz; coal, 139,533 tons (all from Selangor, and excluding coal produced and consumed at the colliery); china clay, 173 tons; and haematite, 275 tons (all from Perak). Exports include wolfram, 4 tons; scheelite, 60 tons; and amang, 3,039 tons.

MALAY STATES (UNFEDERATED) AND MALACCA

According to returns furnished by the Chief Inspector of Mines, exports of minerals during the last quarter of 1939 were as shown below.

EXPORTS OF MINERALS, OCTOBER-DECEMBER 1939

State.	Tin in ore at 75·5 per cent.	Gold.	Manganese ore.	Wolfram.	Bauxite.	Iron ore.
	Long tons.	*Oz.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Johore	345	—	—	—	21,366	146,867
Kedah	130	—	—	43	—	—
Perlis	629	—	—	—	—	—
Kelantan	7	152	1,598	—	—	34,350
Trengganu	153	—	4,150	34	—	237,000
Malacca	124	1	—	—	—	—
Total	1,388	153	5,748	77	21,366	418,217

JOHORE

The following progress report on mining in the State of Johore during the last quarter of 1939 has been compiled from a statement submitted by the Acting Warden of Mines.

Tin Ore.—The production of tin ore continued to be regulated, and exports cannot be greater than the permitted quota release for each quota period, which corresponds to a quarter of a year.

Exports of tin ore from all sources during the three months October to December amounted to 345·45 tons, valued at $662,790·17. This represents a decrease of 12·30 tons exported as compared with the previous quarter, though the value and amount of duty paid were increased by $145,590·87 and $16,735·19 respectively.

During the fourth quarter the tin ore exports from Johore Bahru amounted to 174·63 tons, from Kota Tinggi 152·00 tons, and from Penggerang 18·82 tons.

There is an interesting difference in the proportions of tin ore exported from European owned or managed mines and that exported from mines under Chinese management during the third and fourth quarters of 1939. The European proportion rose from 42·32 to 60·56 per cent. and the Chinese proportion fell from 57·68 to 39·44 per cent. The large proportionate increase in the export from European mines was due to their greater ability to produce the sudden and unexpected quota release during the fourth quota period.

Iron Ore.—Exports of iron ore for October amounted to 56,333·40 tons, for November 39,913·20 tons and for December 50,620·70 tons. The total export of 146,867·30 tons being valued at $734,336·50. Of this total 43,672·00 tons were exported from Endau (East Coast) and 103,195·30 tons from Batu Pahat (West Coast).

In Johore iron ore is valued at $5·00 per ton for the purpose of assessing export duty, which is 10 per cent *ad valorem*.

Export from the iron mine on the east coast ceased in November, but will be resumed after the finish of the monsoon.

Bauxite.—Two open-cast bauxite mines were worked during the quarter. The Kim Kim mine, which is situated near Pulau Nanas on the south coast of Johore, was not operated. The exports of ore amounted to 13,047·84 tons in October, 6,530·48 tons in November and 1,787·73 tons in December. The total of 21,366·05 tons, valued at $106,830·25, was exported entirely from Batu Pahat on the west coast.

In Johore the assessment valuation and export duty for bauxite are estimated at the same rate as for iron ore, the value being $5·00 per ton, and the export duty 10 per cent. *ad valorem*.

Gold.—During October two small alluvial gold workings produced 2·593 troy oz. valued at $150.39. There was no production in November or December.

A royalty of 2½ per cent. *ad valorem* is paid on all gold produced,

the price being fixed at $58.00 per troy oz. for the purpose of assessing royalty.

NORTHERN RHODESIA

Water Supply.

The following interesting preliminary report on water supply operations carried out in Northern Rhodesia during 1939 has been submitted by the Director of Water Development. This work is the beginning of a new five year programme to be accomplished with the aid of a grant from the Colonial Development Fund. A more detailed statement will be issued shortly in the form of an annual report.

During the second half of the year twenty-four wells were constructed in the Fort Jameson District of the Eastern Province, thirteen of these were in Reserve II and eleven in Reserve IV. The average depth of the wells is 44 ft. They are lined with concrete and are fitted with a simple form of windlass, chain and bucket. The majority lie along the banks of dry stream courses traversing a plateau underlain at a depth of a few feet by rocks of the basement complex.

The wells are much appreciated by the natives, and were extensively drawn upon throughout the latter part of the dry season. They provide water at or near all the required points in the two Reserves and serve to ameliorate the conditions of existing villages as well as to facilitate the cultivation and opening up of outlying "dry" areas.

The programme of well construction originally planned for 1939 has been successfully completed in spite of serious handicaps. There was a short season amounting to only half the normal dry season. The work had to be started with entirely untrained European and native staff, and all plant and stores had to be ordered and assembled relatively late in the season under the additional disadvantage of war conditions. The drill ordered in June for work in the Eastern Province was commandeered for war purposes, but another is expected to arrive in its place and drilling will be carried out as arranged.

Detailed plans have been drawn up for the continuation of the work in 1940 and 1941. They relate mainly to the Fort Jameson District, but in part also to the Petauke District, and include the construction of about forty wells and six boreholes in Reserve II of the former area. This work will bring about an urgently needed improvement to the water supplies of numerous villages and will open up a number of isolated localities for new cultivation and settlement. Moreover, the raising of food crops in the Reserve will be placed on a sounder footing for both present and future needs.

Plans for 1940 include the surveying of parts of the Central and Southern Provinces with a view to the early commencement of

water supply operations similar to those now in progress in the Eastern Province.

MINING ACTIVITIES.

The following statements relating to mining activities in Northern Rhodesia during the first quarter of 1940 are taken from a report furnished by the Chief Inspector of Mines.

Prospecting.—Only eleven prospecting licences were issued during the quarter and there was little activity. Normal operations were continued on the Rhokana Corporation, Ltd., concession, but prospecting was only in progress on the Choma Tin, Ltd., concessions during January and no work was carried out on the Rhodesia Minerals Concessions, Ltd., area. The only location registered was one for alluvial gold.

Mining.—The quarter was, unfortunately, marred by a brief strike of Africans at the Nchanga Mine, and strikes of Europeans and Africans, though not both at the same time, at the Mufulira and Nkana Mines. The Europeans returned to work before the end of the quarter and the Africans have returned since. These strikes naturally resulted in a falling off in both blister and electrolytic copper production; there was also a considerable reduction in the production of cobalt alloy. The total value of the minerals produced during the quarter was £3,201,810 as compared with £3,483,976 during the preceding quarter.

MINERAL PRODUCTION, 1940
(January-March)

Gold*	1,250 *oz.*
Silver*	37 ,,
Cobalt alloy	9,501 *cwt*
Copper, blister	54,725 *ton*
,, electrolytic	6,587 ,,
Iron ore	71 ,,
Vanadium pentoxide	162·5 ,,
Lead	59 ,,
Zinc	3,100 ,,
Limestone	13,266 ,,
Mica	400 *lb.*

* *Subject to adjustment.*

Gold.—At the Chakwenga mine the mill was put into commission and approximately 1,400 tons of development ore from the dumps treated; the gold recovered was estimated to amount to 61 oz. of bullion.

At the Dunrobin mine 6,582 tons of ore were treated during the quarter and bullion containing approximately 1,238 oz. of fine gold recovered.

At the Msidza mine, an alluvial prospect in the Lundazi District, treatment by means of sluice boxes was started during March and approximately 12 oz. of gold recovered.

Copper.—The quantities of ore treated and metal produced by the Mufulira, Nchanga, Nkana and Roan Antelope mines are shown in the subjoined table.

Mine.	Ore treated.		Copper recovered.				Copper content.
			Blister.		Electrolytic.		
	Tons.	*Per cent. Cu.*	*Tons.*	*Per cent. Cu.*	*Tons.*	*Per cent. Cu.*	*Tons.*
Mufulira .	536,354	4·52	18,901	99·51	—	—	18,808
Nchanga .	31,719	5·85	1,422	99·72	—	—	1,418
Nkana . .	737,054	3·47	15,347	99·73	6,586,707	99·95	21,889
Roan Antelope	716,160	3·05	19,055	99·48	—	—	18,954
Total .	2,021,287	3·64	54,725	99·57	6,586,707	99·95	61,069

By-products recovered at the Nkana mine included 9,501 cwt. cobalt alloy (averaging 40·7 per cent. cobalt and 20·13 per cent. copper, and containing 3,868 cwt. of cobalt metal).

At the Mufulira mine development from No. 5 Shaft was in progress on the 1,150 ft. and 1,450 ft. levels. The use of detachable rock-drill bits, which it has been decided to adopt as a standard practice, was extended. The erection of the new direct-fired boiler and 14,000 k.w. turbo-alternator was completed.

At the Nchanga mine the sinking of the two inclined shafts was continued and development and work in preparation for a block-caving method of stoping carried out. Following a very serious accident in the vertical shaft the temporary rope guides were replaced by permanent steel ones. Orders were placed for the larger units of the permanent mill.

At the Nkana mine the sinking of the No. 1 winze below the 1,450 ft. level was completed, the final depth being approximately 2,000 ft. The main cross-cuts from the central shaft were started on the 1,680 ft., 1,910 ft., 2,140 ft. and 2,370 ft. levels, and the excavation of ore and waste passes and of a loading pocket at the 2,450 ft. level also commenced. In the Mindola section the 1,420 ft. level pump station was brought into operation.

At the Roan Antelope mine stoping was commenced in the Storke shaft section, above the 1,440 ft. level, and a new ventilation fan, with a capacity of 150,000 cu. ft. a minute was brought into commission. The training of two rescue teams, using "Proto" apparatus, was completed.

Zinc and Vanadium.—The Broken Hill mine treated 15,407 tons of ore averaging 23·06 per cent. Zn, 4·14 per cent. Pb, and 0·46 per cent. V_2O_5, and recovered 1,697 tons of electrolytic zinc (99·98 per cent. Zn), and 1,403 tons of debased zinc (99·27 per cent. Zn), giving a total of 3,100 tons averaging 99·66 per cent. Zn, and containing 3,089 tons of zinc metal.

The company further treated 16,447 tons of vanadium ore containing 1·17 per cent. vanadium and recovered 162·50 tons of fused vanadium pentoxide containing 203,923 lb. vanadium.

In the Davis Shaft section the installation of the settlers and,

with the exception of some of the motors, of the main pumps was completed and pumping started. Thereafter work was concentrated on diamond drilling to increase the flow of water. The new hoisting shaft reached a depth of 328 ft. Work on the extension of the treatment plant was continued.

SARAWAK

According to the Chief Secretary, the reported production of gold for the period September 1 to November 30, 1939, was 4,399 fine oz., of which 39 oz. came from the Kuching District and the whole of the remainder from the Bau District. The area covered by Mining Leases at the end of November was 6,736 acres, and, of the 39 leases extant, two cover quicksilver and the rest gold and silver. Nine exclusive Prospecting licences for gold and silver, each issued for a term of one year and covering in all 1,646 acres, were in existence on November 30.

It was reported that 14 tons of antimony ore were exported during the three-month period.

SIERRA LEONE

The Acting Chief Inspector of Mines reports the following mineral production for the fourth quarter of 1939. The corresponding figures for the fourth quarter of 1938 are shown for comparison :

Mineral.	October to December, 1939.	October to December, 1938.
Gold—crude and unrefined bullion	8,682 *troy oz.*	8,461 *troy oz.*
Gold—estimated fine gold . .	7,922 ,,	7,761 ,,
Platinum—coarse crude . .	30 ,,	12·5 ,,
Chromite	4,463 *tons*	nil

The figures for diamond production and iron ore exports are not available.

The average number of Africans employed in prospecting during the quarter was 130. Those employed in mining numbered 12,698, and in miscellaneous services in connection with the industry 318.

TANGANYIKA

The following report on the mineral production of Tanganyika has been received from the Acting Chief Inspector of Mines and Chief Geologist.

The outstanding features of the latter part of 1939 were firstly the outbreak of war, and secondly, the announcement at the completion of the year of the attainment of a record mineral production. The value of this exceeded the million pound mark for the first time in the history of the Territory.

The quantity and value of minerals produced during the full year are shown in the following comparative table :

Mineral.	1939.		1938.	
	Quantity.	Value (£).	Quantity.	Value (£).
Gold (bullion)	187,254 *troy oz.*	980,346*	112,267 *troy oz.*	588,679
Salt	9,322 *tons*	52,047†	9,525 *tons*	53,938
Tin ore	311 „	50,605*	368 „	50,460
Mica (sheet)	30 „	15,335*	22 „	12,383
Mica (ground)	5 „	68	14 „	314
Diamonds	3,445 *carats*	12,255*	3,576 *carats*	3,558
Building materials	—	—‡	—	2,177
Tungsten ore	6 *cwt.*	51	67 *cwt.*	622
Red ochre	29 *tons*	143	57 *tons*	250
Phosphates	—	—	68 „	239
Talc	—	—	37 „	110
Total value		1,110,850		712,730

* *Estimated.* † *Provisional.* ‡ *Not yet available.*

At the outbreak of war a certain amount of dislocation occurred in some of the gold mines, where a large proportion of the staffs were enemy subjects. This dislocation was most acute in the mica industry, since the principal producer was an enemy-controlled mining company that employed a completely German staff.

In connection with supplies of mining stores, it was feared that a severe shortage of certain essentials might occur to handicap the production of the minerals necessary for the war. Steps were promptly taken to ascertain what stocks were held in the country and what normal consumption amounted to per month. Fortunately no undue shortage has occurred so far, although anxiety was felt for a time over threatened shortages of mercury and sulphuric acid until new shipments arrived.

UGANDA

The following report has been received from the Director of the Geological Survey regarding mining activities in Uganda during the period January to March 1940.

Gold.—Decreases in the monthly figures of gold returns still continue, and it is evident that unless new finds are made outside the known Buhwezu and Kigezi areas the amounts will show a further fall. Provisional figures for January to March show that 2,786 fine oz., valued at £23,396, were exported. Last year during the same period the exports amounted to 4,986 oz., valued at £37,006.

Work on the lode-bearing area around Busia in the Eastern Province has also slowed down considerably and is confined to open-cast workings.

Tin.—Tinstone exports, while remaining generally of the same order as in former years, show, in fact, a slight increase, approximately 119 tons of concentrates valued at £21,313 being produced during January to March; the figures for the same period last year were 78 tons valued at £17,286. Several small tin claims were opened up during this quarter, but none suggest large developments.

Tantalite.—As in the corresponding period last year no tantalite was exported, but work continues on the high grade ore mentioned in previous reports. The amount won, however, must necessarily be small because the lode itself is of no considerable size and the tantalite occurs in irregular patches.

Quartz Crystal.—Some amount of quartz crystal was discovered by officers of the Geological Survey and has been exported; many of the Buhwezu occurrences were visited and a choice made of the most promising ones for work in the future.

Oil.—After sinking a second deep hole to just over 800 ft. at Kibero, the company operating on Lake Albert decided to relinquish the concession. One deep hole had been put down at Butiaba, 10 miles to the north, and two at Kibero; many shallow holes had also been drilled in the same region. No exploration, however, was undertaken in the two areas where the Kaiso Beds exhibit their greatest expanse above water, i.e. at the southern and northern ends of the lake.

ABSTRACTS AND NOTES

New Zealand Mineral Production.—The following information regarding mineral production during the last quarter of 1939 and the first quarter of 1940 has been supplied by the Under-Secretary of the Mines Department.

AURIFEROUS QUARTZ MINING

	September 24 to December 31, 1939.			January 1 to April 6, 1940.		
Mines.	Quartz treated (*Tons.*)	Gold produced (*Fine oz.*)	Silver produced (*Fine oz.*)	Quartz treated (*Tons.*)	Gold produced (*Fine oz.*)	Silver produced (*Fine oz.*)
North Island						
Martha . .	49,411	12,231	100,536	48,847	12,559	114,071
South Island						
Alexander .	861	395	—	655	261	—
Big River .	271	222	—	370	356	—
Blackwater .	12,696	5,972	—	11,591	6,084	—

GOLD DREDGING

Dredges.	September 24 to December 31, 1939. Cubic yardage treated.	Gold produced (*Troy oz.*)	January 1 to April 6, 1940. Cubic yardage treated.	Gold produced (*Troy oz.*)
South Island—				
West Coast District				
Argo	161,500	476	138,600	402
Arahura	1,074,000	3,789	1,051,000	5,745
Barrytown	472,000	2,852	699,000	4,678
Blackball Creek	(1,146 hours)	664	(1,135 hours)	461
Gillespie's Beach	(650 ,,)	151	164,900	384
Grey River	1,310,000	4,494	1,215,430	4,837
Kanieri	697,000	3,942	881,000	3,344
Mataki	122,000	278	79,000	156
Mataki Junction	142,000	313	—	—
Mossy Creek	54,600	302	73,110	375
Nemona	24,500	72	66,000	152
New River	43,700	129	101,680	293
Okarito	(1,093 hours)	207	(534 hours)	52
Rimu	408,540	1,471	582,900	2,232
White's Electric	65,900	329	55,900	228
Worksop	168,300	239	98,900	221
Ngahere	—	—	373,700	652
Maori Gold	—	—	—	18
Otago District				
Clutha	(unknown)	489	(unknown)	1,008
Molyneux	151,192	822	216,000	1,040

Manganese.—Production of ore from the deposit at Moumoukai, near Papakura, was postponed owing to delay in obtaining the necessary equipment. This, however, was obtained during the last quarter of 1939, and it was expected that mining would commence during April. The workings are known as the "Cloudesley Mines."

Mercury.—Prospecting and testing operations are being carried out in the Puhipuhi district, Whangarei County, by a Syndicate which has taken up several areas in this locality. Approximately 10,000 yds. of overburden have been removed by the use of an excavator, and crosscuts and boreholes have been put through the main deposit with encouraging results. The Syndicate intends to erect plant for the treatment of the ore.

New Geological Map of the Gold Coast.—Although field-work carried out since the appearance in 1928 of the first geological map of the Gold Coast (on a scale of 1 : 1,500,000) has corroborated the substantial accuracy of that early map on broad lines, the details which have now accumulated have necessitated a number of important modifications. These have been incorporated in an entirely new geological map of the Gold Coast on a scale of 1 : 1,000,000 which has been published together with a map (on about half that scale) of the major trend-lines of the formations. Explanatory notes on the formations, on the evolution of the coast-line, and on the intrusive rocks, accompany these two maps and constitute *Bulletin No.* 11 (1940) *of the Gold Coast Geological Survey*, "Geology of the Gold Coast and Western Togoland," by N. R. Junner.

The most notable change which is evident on comparing Kitson's early map with the present one, is the adoption of an entirely new and pleasing code of colours for the various geological formations, but these are somewhat different from the colour-code used in the "Southern Sheet" of the Gold Coast (1935). The Survey have also, in the present and other maps published since 1928, commendably discarded the practice employed in the first geological map of designating the formations by a code-letter referring to their believed South African equivalents. Thus, for example, the Tarkwaian is now denoted by T instead of by Wd (Witwatersrand) and the Vollaian by V instead of by Wg (Waterberg). In both the index to the map and the explanatory notes, correlation has been restricted to the broad European equivalents (Archean, Pre-Cambrian, etc., up to Cretaceous, Pleistocene and Recent) of the formations encountered in the Gold Coast.

There are a number of important modifications and additions to the boundaries of the formations, but the scale of the map has naturally not allowed for the inclusion of the many smaller roof-pendants and variations in the larger masses of granite, nor of the smaller sills and dykes.

The explanatory text of the Bulletin, in which the new map is incorporated as a folder, provides an admirable account of the present conception of the major stratigraphical and structural features of the geology of the Gold Coast. The petrology of the igneous rocks also receives considerable attention, and this includes a number of chemical analyses carried out at the Imperial Institute.

The Mineral Resources of North Borneo.—The existence of mineral wealth, particularly of alluvial diamonds, in that part of the island of Borneo which is known as the State of North Borneo, has been known for a very long time, but the principal records dealing with the prospecting and exploitation of this wealth are those dating from the end of the eighteenth century.

In *Asiatic Review* (**36**, No. 126, pp. 359-371), W. J. Worth has reviewed and summarised the more important of these records which are to be found in published sources, official returns, and company reports.

Gold.—According to some of the earlier records, gold production was carried on to such an extent in the Darvel Bay region in the eighteenth century that it was the principal activity of that district, and the existence of a gold mine in the Tampassuk district on the west coast of the State during the same period is also on record.

Subsequent to the granting of a charter in 1881 to the British North Borneo Company, considerable amounts have been spent on prospecting in the State, which has resulted in the discovery of alluvial gold, principally in the Segama River and some of its tributaries, as well as in a number of smaller rivers in the south-eastern part of the territory, but in spite of this widespread

occurrence of alluvial gold no important deposit has been located *in situ*.

Diamonds.—Although there are references in early works to the existence of a diamond mine on the west coast of North Borneo near Mengkabong, many efforts to locate the site of the mine have failed to yield tangible results.

A potential diamond deposit is that of the Labuk River clays, which have been recognised by South African experts as typical blue ground. A four-ton sample of this ground however, which was sent to London for treatment in 1904 failed to yield a single stone.

Silver and Lead.—Silver, associated with galena, has been reported from various localities in the south-western part of the State. A sample from each of two of these localities assayed 115 oz. and " not less than 500 oz." respectively. All the samples, however, appear to have consisted of float or water-worn material and in no case has it been possible to locate the ore *in situ*.

Mercury.—Cinnabar is known to occur in several localities in the island of Borneo and frequently occurs in association with gold. Samples are said to have been obtained from the Tampassuk River, the Segama River, and the Kaumut River. Two of such samples from the Segama River assayed in London yielded as much as 75 per cent. of mercury, but again no occurrences have been discovered *in situ*.

Chromium and Platinum.—Black sands containing chromite occur on the beaches of the eastern and western peninsulas of Marudu Bay and the neighbouring islands off the extreme north-eastern part of Borneo. One of these was found to assay 47·5 per cent of chromic oxide in addition to being auriferous and argentiferous.

In addition, massive chromite, in the form of boulders, has been discovered disseminated over a considerable area near Paranchangan on the upper Sugut River. The average chromic oxide content of this chromite is 53·60 per cent. In the black sands of Banguey Island platinum occurs in the not inconsiderable tenor of six grains per cubic yard, but no information is available as to the yardage present.

Manganese.—Considerable deposits of manganese ores, chiefly psilomelane with some pyrolusite, have been discovered in the Taritipan district on the eastern peninsula of Marudu Bay. Subsequently it was decided to exploit these deposits, but shipments of the ore made abroad failed to come up to specification, and this, coupled with the fact that the ore, though high-grade on the surface, has a silica content which increases with depth, has resulted in the abandonment of the deposits.

The occurrence of manganese ores in the form of boulders, some assaying 60 per cent. of manganese, has also been recorded in the Mount Madai region of Darvel Bay.

Copper.—Both native copper and copper pyrites have been located in a number of places in North Borneo. One of these, a cupriferous lode of iron pyrites assaying over 5 per cent. of copper

occurs on one of the tributaries of the Kinabatangan River. This deposit was intensively prospected between 1909 and 1912, when a length of 1,000 ft. and a width averaging 6½ to 10 ft. were proved to exist above water level. Associated with this lode are others of massive pyrites, which though smaller, were richer in copper assaying in places up to 17 per cent. Further operations on this prospect were abandoned in 1912 owing to lack of capital.

On the Meliao River, a tributary of the Labuk, at Pingan Pingan on Marudu Bay, on the Sualog River (Labuk delta) and on Mount Tambayukong and Mount Nungok, quartz veins carrying varying amounts of copper pyrites and iron pyrites have also been discovered.

Iron.—Extensive deposits of iron ore occur in North Borneo. Those at Tagako, south of Marudu Bay, cover 4½ sq. miles and are described as limonite assaying 52·24 per cent. of iron and 0·21 per cent. of sulphur.

On the Purog River, 1,500,000 tons of ore averaging 63·50 per cent. of iron, 0·052 per cent. of sulphur and 0·203 per cent of copper are said to be exposed.

Similar ores in considerable quantity have also been located on the Karang River.

Tin.—Cassiterite has frequently been alleged to occur in North Borneo, but the only authenticated occurrence appears to be that by a French mining engineer who reported the mineral in a valley about 1 mile from Tawua. The cassiterite, which assayed 20 to 40 grams per cu. dm., occurs in a siliceous conglomerate.

Antimony.—Several native reports of the existence of antimony ores in North Borneo have never been confirmed by European investigation, although the mineral is of wide distribution in the rest of the island of Borneo.

Other Minerals.—Asbestos, talc, zinc, wolframite, rutile and zircon also occur in a number of localities in North Borneo, but in no case on such a scale as to warrant their exploitation.

Coal.—Deposits of coal are of fairly widespread occurrence in North Borneo, but not to the exaggerated extent that was at one time claimed for them. The most important of the deposits are those in the Cowie Harbour district in the south-eastern part of the State. These were worked from 1900 to 1930 when, owing to difficulties of transport from the mine at Silimpopon to Tawau and Sandakan on the coast, operations were suspended.

Oil.—The existence of oil, as indicated by seepages, was discovered soon after the State came under British control, but prospecting and drilling operations by a number of companies have not produced any greatly encouraging results, though this fact had not prevented an important oil group continuing boring operations up to the outbreak of the present war.

Haematite Discoveries in Newfoundland Labrador.—Deposits of magnetite have long been known in western Labrador and the

Ungava district of Quebec, but little detailed work was ever carried out. During four field-seasons, from 1936 to 1939, the Labrador Mining and Exploration Co. has discovered extensive deposits of hæmatite in its concession area in westernmost Labrador. Most attention seems to have been given to a deposit at Sawyer Lake, and the company's chief geologist, Dr. J. A. Retty, has published an account of this deposit in *The Northern Miner*, March 7, 1940.

The concession area, about 20,000 sq. miles in extent, lies at the headwaters of the Hamilton and Naskaupi Rivers and a central base-camp has been established at Sandgirt Lake, 264 miles north of Seven Islands in the Gulf of St. Lawrence. This region includes a portion of the Labrador trough (a belt of late pre-Cambrian sedimentary and volcanic rocks extending for over 300 miles in a N.W.-S.E. direction), in which there is an extensive development of iron formation and which is geologically similar to the Lake Superior district with its iron ranges. The iron formation consists of alternating bands of chert and hæmatite, usually varying in thickness from 1 to 3 in., and generally wavy-bedded or brecciated and recemented with hæmatite. With it are associated a thick arkosic grit, intruded by a gabbro sill, quartzites, slates and a volcanic series consisting mainly of andesites with flow breccias and tuffs, which probably overlies the sediments unconformably. The sediments have been folded into a broad symmetrical syncline running north-east through Sawyer Lake, with the eastern limb exposed on the east side of the lake. The southern heel is partly exposed just beyond the southern edge of the lake.

In 1937 Dr. Retty was conducted to the Sawyer Lake deposit by a Montagnais Indian, named Mathiau Andre, who had brought in a sample of high-grade hæmatite. Stripping, trenching and test-pitting were carried out in 1938 and 1939. The ore outcrops on an elliptical hill 100 ft. above the level of the surrounding country and although exposures are mainly confined to isolated hills, the geological succession in the immediate vicinity appears to be in ascending order, quartzite, iron formation, volcanics. The ore-body is confined in great part to a zone at the top of the iron formation and in places is overlain directly by andesites. Its exact thickness cannot be determined owing to its irregular outline. The ore is a massive, dense, greyish-blue, hard hæmatite containing a small amount of magnetite. Analyses of 148 samples from channels averaging 10 ft. in length gave an average of over 65 per cent. iron. The phosphorus content was between 0·03 and 0·04 per cent., and analysis of one sample, containing 69 per cent. iron showed 0·51 per cent. manganese, 0·44 per cent. silica, 0·30 per cent. alumina, and 0·01 per cent. sulphur. It has been estimated on the basis of work done to date that the deposit contains 2,200,000 tons of ore per 100 ft. of depth, and as ore can be seen at points separated by a vertical distance of 100 ft., it is suggested that the ore extends to at least that depth.

Five other discoveries of iron ore have been made within the region. One of these is a siliceous deposit that can be traced for five miles along the strike. The remaining four are of good grade, one of them containing high manganese. Dr. Retty believes that the area has excellent possibilities for further discoveries and that exploration along the Labrador trough will undoubtedly lead to the discovery of many more deposits of iron ores as well as of other metals.

Diamonds in Tanganyika.—The Kimberlite pipes of Tanganyika Territory constitute the most extensive group outside the Union of South Africa and South-West Africa, and it is surprising, therefore, that so little has hitherto been published about these occurrences. In *Bulletin No. 12 of the Geological Division of the Tanganyika Department of Lands and Mines*, G. J. Williams has compiled a comprehensive account, from original, published and unpublished work, of the geological and economic aspects of the occurrence of diamonds in the Territory.

It is believed that diamonds were first discovered in Tanganyika just before the war of 1914-1918, but it was not until 1921 that serious interest was taken in them. Prospecting centred around Mabuki, the scene of the first discovery, but though subsequent exploration for diamonds has been carried out with varying degrees of success in many other parts of the Territory, nothing of the same order of importance as the Mabuki deposits has been brought to light.

Noteworthy production commenced in 1925 and reached a maximum of 24,680 carats by 1928, after which output fell off to 1,155 carats in 1934, although there was a recovery to 3,230·5 carats in 1937, the last year for which figures are available. The largest single stone recorded from Tanganyika is one of 92½ carats, but it is surpassed in value by one of 37¾ carats worth £1,699, which was also discovered in 1930.

The occurrences of Kimberlite are found within the central granite batholith of Tanganyika, which is intruded into metamorphic rocks, and belong entirely to the Upper Basement Complex of the Archean era.

As with Kimberlite bodies elsewhere, their distribution cannot be readily related to any major tectonic or other geological features, although the distribution of a small group may have recognisable local relationships. This absence of any major genetic relationship means that prospecting cannot be restricted to areas with outstanding probabilities.

The geological evidence available from Tanganyika is insufficient for the precise determination of the age of these Kimberlite bodies, but supported by evidence from elsewhere, it has been deduced that they must be pre-Pleistocene and are probably post-Lower

Jurassic and possibly belong to a single eruptive period in late Cretaceous times.

The greatest production has been from the Mabuki deposits with a total output of over 95,000 carats, but the main body of this deposit was exhausted in 1930. These deposits consist either of rounded or subangular gravel or of a boulder wash overlying both the Kimberlite pipe and the metamorphic rocks which surround it. The author considers that the theory of the origin of the diamonds in the gravels from the underlying diamondiferous kimberlite is incontrovertible.

The Mwamanga pipe (" the Lake Prospect ") which covers nearly 20 acres, is the most northerly pipe in Africa and the largest in Tanganyika. This pipe was discovered as a result of an attempt to trace the possible migration of diamonds from the Mabuki pipe under the Magogo River flats. With the consequent lowering of the tenor which would result from deposition over these wide flats, however, the prospect of locating payable deposits is rather remote. Nevertheless the possibility of the existence of other pipes beneath the overburden above the metamorphic rocks between the Magogo and Sandy Rivers is not precluded.

The Kisumbi deposits consist of kimberlite pipes, seven of which have been found, and of diamondiferous gravels, the latter having been the principal source of the production of 7,334 carats from this field which was abandoned in 1938. The detrital deposits, which are known as the Boshoff gravels, consist of sporadic bands of chert gravels which are described as originating from the colluvial accumulation in depressions in the peneplain surface under arid climatic conditions.

In addition to the deposits described above, a considerable number of other pipes and gravels have been discovered in the Territory both in the Shinyanga, Usongo, and Singida districts. Some of these have been worked, in cases to the point of exhaustion, whilst others have been more or less thoroughly prospected. Many of these occurrences have thus been ruled out as further commercial prospects, but it is emphasised that there are profitable possibilities for the small worker in diamonds in the Territory.

Diatomite in Brazil.—Deposits of diatomite in Brazil have been exploited for a number of years, an interesting example being that, without knowing the precise nature of the raw material being used, the town of Fortaleza, capital of the State of Ceará, in the north-east of Brazil, has been almost entirely constructed with lightweight diatomite bricks. Brazil is, therefore, unique among tropical countries in having a high proportion of thermally-insulated buildings even though this usage was originally fortuitous.

Diatomite is known to occur in Brazil in the States of Rio de Janeiro, Maranhão, Pernambuco, Rio Grande do Norte and Ceará.

Some of the more important of the deposits occur in the two latter States, and these have been supplemented by several new discoveries within the last few years. Many of these deposits in the north-eastern part of the country have recently been visited by de Souza and Abreu and described by them in "Diatomito do Nordeste", *Bull. No.* 33, *National Department of Mineral Products, Rio de Janeiro*, 1939.

With one exception, the deposits in the State of Ceará are all conveniently situated within a few miles of the town of Fortaleza. They are located at Mecejana, 18 km. south of Fortaleza, at Euzebio, south-east of Mecejana and at Maraponga, south-west of Fortaleza.

In the State of Rio Grande do Norte, the principal deposits are also situated in the coastal belt, notably at Papara, San José, Natal, Macaiba, and Ceará-Mirim.

The only deposit in north-eastern Brazil which is not located in the littoral belt is that at Missao Velha in the extreme south-eastern corner of the State of Ceará.

Generally the deposits occur in lagoons or fens among sand-dunes, and, particularly in the littoral belt, may be permanently or intermittently under water. Altogether, many millions of tons of diatomite are believed to be available, and as the local fabrication of lightweight bricks consumes about 100,000 tons annually, a supply is ensured for a considerable number of years to come.

In no case do the deposits attain any notable thickness—one-third of a metre up to two or three metres being instances recorded. The exploitation of these shallow deposits is by manual methods in patios or paddocks (after removal of the overburden) either during periods when they are dry or from rafts when and where the deposits are submerged. Although these hand methods are in general use, some of the deposits are of sufficient size and quality to warrant mechanical means of extraction.

In Pernambuco a diatomite product with over 94 per cent. of silica has been obtained, but this is considerably higher than the average silica content of the diatomite from the north-eastern part of the country. The chemical analyses in the accompanying table show that in the raw material the silica content ranges from 51·7 to 88·2 per cent., but in view of the usual mode of occurrence of these deposits it is not surprising to find that there is a comparatively high content of moisture and volatile material resulting in a high loss upon igniting the raw material. Ignition losses up to 27·4 per cent and humidity losses up to 8·8 per cent have been recorded in this way. Upon air-drying and calcining, therefore, an appreciable beneficiation as regards silica content takes place. Hence, Brazilian diatomite compares quite favourably in silica content with many diatomites from other parts of the world, but its alumina content is frequently quite high, and in places the material is essentially of the nature of a clay-with-diatoms.

ANALYSES OF BRAZILIAN DIATOMITES

	1.	2.	3.	4.	5.	6.	7.	8.
SiO_2 . .	75·3	72·7	60·6	51·7	64·0	87·0	87·9	74·4
Al_2O_3 . .	9·3	10·5	17·6	10·7	19·4	2·6	1·7	1·1
Fe_2O_3 . .	0·6	2·9	1·2	1·9	1·8	1·8	0·2	0·1
TiO_2 . .	Tr.	Tr.	—	0·2	0·4	0·5	—	—
Ca O . .	Tr.	Tr.	—	0·4	nil	0·2	0·2	0·1
Mg O . .	—	0·3	—	0·2	nil	Tr.	nil	nil
Moisture .	7·6	3·0	4·9	6·5	8·8	4·2	6·5	8·2
Loss on ignition	7·7	10·8	16·4	27·4	5·1	3·7	3·3	16·2
				99·0	99·5	100·0	99·8	100·0

1. Lagôa Crassui—Soure, Ceará.
2. Lagôa dos Doidos, Rio Grande do Norte.
3. Carrapato, Jundiai, Rio Grande do Norte.
4. Lagôa Grande de Jundiai, Rio Grande do Norte.
5. Lagôa de Cima banks, Campos. Rio de Janeiro.
6. Salgado farm, Tutoia, Maranhão.
7. Alto Rio Branco, Amazonas.
8. Dois Irmãos, Recife, Pernambuco.

Although the silica content is, on the average, considerably higher than in "moler," the well-known Danish clay-with-diatoms, certain varieties of the Brazilian material, notably that from Carrapato, Jundiai, are said to bear a marked resemblance to moler.

Whilst there are naturally variations from place to place in Brazilian diatomite, it may be described as being characterised by a white to cream, ash-grey, or black colour, light weight, fine-grain texture, low iron content, and a degree of plasticity varying with the clay content. Typical apparent densities in the powdered form which have been recorded are 0·26, 0·32, 0·73, and 1·09. A notable feature of many varieties is the high proportion of sponge spicules, the average length of which is from 0·25 mm. to 0·5 mm. The diatoms average ·01 to ·05 mm. in length and some of the more abundant genera identified include *Melosira*, *Eunotia*, *Pinnularia*, *Navicula*, *Actinella* and *Anomœoneis*, some species of which, it is interesting to note, are cold-water types.

One of the difficulties of the Brazilian domestic industry, which is believed to have an output of rather less than 200,000 bricks a day, has been that of finding natural grades of the material which at the same time combine sufficient argillaceous material to render it plastic with a sufficient proportion of diatoms to produce the desired lightness in weight. In addition, imperfections in the burning of the bricks also result from the rather primitive types of oven employed.

Certain varieties of Brazilian diatomite appear to be suitable for the manufacture of filter-aids as they are actually in use in the sugar-refining industry in the Pernambuco district. This, however, is not an important trade in the Brazilian domestic market, which, as indicated, is principally concerned with building materials.

A Novel Method for the Reduction of Refractory Gold Ores.—The reduction, on an experimental scale, of certain complex Rand ores, in particular, antimonial and arsenical gold ores, by an entirely new and patented process, was recently demonstrated in Pretoria before representatives of the Government, the mining industry and the press.

According to *South African Mining and Engineering Journal*, 1940, **50**, (2), p. 723-725, the ore, after grinding by familiar methods, is thoroughly mixed with coal tar, the mixture then being placed in a metal container with an air-tight lid termed an absorption chamber. This chamber and its contents are then maintained at a temperature between dull and bright red heat for a period of time sufficient to convert the mixture into a coke-like product which is then roasted in an oxidising furnace. This treatment, which it has been found, is best carried out in a tubular type of furnace, results in the driving off of the oxidisable and volatile constituents in gaseous or vapour form after which the resulting mass is treated by customary methods for recovery of the gold content. In certain cases it may be possible to recover these gases and vapour as valuable by-products.

The scientific principles underlying this process have not been precisely formulated, but it is believed that the low melting point and high thermal conductivity of the tar allows this coke-like mass to be formed, for example, in the case of antimonial ores, before the stibnite either melts or frits. This appears to be due to some physical and chemical modifications of the mineral which take place under the influence of heat in the presence of tar. In general, therefore, the action of the tar is that of a potent desulphurising agent.

In an actual experiment, 10 lb. of a finely-ground stibnite ore from the Barberton field was mixed with 10 per cent. by weight of tar and placed in a chamber sufficiently large to allow for the escape of the vapours and gases. This was maintained at a temperature of 400-600° F. for two hours, resulting in the driving off of the excess tar and free sulphur. 1-in. lumps of the coke-like mass were then roasted by placing them on the topmost grid of an oxidising furnace, consisting of a horizontal tube 4 ft. in length and 1 ft. in diameter, in which there are altogether three grids, the upper with $\frac{1}{4}$ in. mesh and the two lower with $\frac{1}{8}$ in. mesh. The tube is equipped for charging and the admission of air at one end and for the discharge of the flue gases and vapours at the other.

During this oxidation dense white fumes, probably of oxides of antimony, are driven off, and the fine grey ash which is produced is raked so that it collects at the bottom of the tube. When the whole of the coke-like mass is thus reduced to ash, it is removed for recovery of the gold by one of the established methods, as, for example, by cyaniding.

In the experiment on the laboratory scale described above, a

recovery of 94 per cent. was recorded, and it is believed that a similar order of efficiency will be obtainable on the commercial scale. In addition to this laboratory apparatus, a pilot plant with a capacity of 4 tons of crushed ore per day has been erected at Pretoria for larger-scale experiments.

Poland's Petroleum Industry under Control.—The partition of the Polish oilfields was considered in the last issue of this BULLETIN (pp. 83-89). Details of the methods subsequently applied in the two confiscated areas have been referred to in *World Petroleum*, 1940, **11**, No. 4, pp. 24-25.

So far as can be ascertained, serious damage to the oilfields and refineries was deliberately avoided during the German invasion, and after the partition the industry was continued by Polish operatives under strict supervision. The structure or, more appropriately, the facade of the industrial organisation has not been changed, but whereas the original companies apparently continue to operate and business organisation is maintained, no accounts of output or details of sales are published. It is reported, however, that the refineries have been adapted, as far as possible, to production entirely designed to meet military needs. No sales are made to private individuals or firms other than those vital to the German war machine.

In the Russian area the owners have been expelled, all stocks removed, and the industry converted into a Government monopoly under the title Ukrneft. An elaborate plan has been drawn up, according to which Ukrneft will, in 1940, drill 200,000 metres of producing wells besides a large amount of exploratory drilling. Should this drilling programme be completed it will represent considerably more than double the average for the past ten years for all Poland under private enterprise. Furthermore, it is stated that, in addition to drilling 300 new wells in the eastern fields, refineries are to be newly equipped and improved transport facilities provided.

Possibilities of raising the total output seem to be doubtful in the Russian-occupied territory, and in the German zone even with new wells, repressuring of old fields, and intensified pumping, a great increase is not to be expected from strata in which reservoir pressure is so easily lost and production stoppages in breakdowns at pumping or swabbing wells are seldom regained.

Mexican Oil Industry after Expropriation.—It is now more than two years since the Mexican Government appropriated the oil properties in Mexico and founded the Petroleos Mexicano (Pemex) to operate the industry. An account of the activities of this Government organisation has appeared recently in *World Petroleum*, 1940, **11**, No. 4, pp. 18-22.

The managing director has declared that the industry has now

an effective daily capacity of 176,000 bls., but not all of this is at present being drawn upon. Production is derived from some 1,000 wells, of which those in the Poza Rica zone, numbering about 40, can alone yield more than 115,000 bls. daily. The cost of production before March 1938 was 1·32 pesos per barrel of 150 litres. After expropriation took place the cost rose to 1·60 pesos, attributed to economic blockade of Mexican sales leading to reduced output, but by the end of 1939 costs had fallen to 1·35 pesos.

Test drilling programmes have been initiated after geological and geophysical surveys, which should prove the capacity of Mexican technicians in this field.

As part of a programme of refinery improvement, declared to be very necessary by reason of the low state of efficiency into which private companies had allowed their plant to fall, the Pemex organisation has announced its intention to instal three large boilers at the refinery at Minatitlan Vera Cruz (one of the largest operated previously by Mexican Eagle), and that it is preparing to improve the Arbol Grande refinery near Tampico, with the provision of a solvents plant. When erected this plant is expected greatly to improve the company's lubricants. The capacity of the refinery is also to be enlarged to double its present daily capacity of 7,000 bls. Pemex has announced that all the equipment will be obtained in the United States.

The greatest problem facing Pemex according to its representatives, is an insufficiency of delivery facilities, but the company hopes to remedy this with a new fleet of ten 10,000 ton tankers, two of which are now in service, delivery of the remainder being scheduled for the end of the summer. These vessels are in addition to the fleet being built in Italy in exchange for oil and its products. The Italian tankers are also expected during the summer.

On account of the acute shortage of railway tank wagons, a large region in western Mexico is being supplied by the apparently costly procedure of sending Government steamers through the Panama Canal, some 7,000 miles, whereas the distance overland is only 1,500 to 2,000 miles.

Government distributors are said to be achieving a measure of success with the distribution in Mexico City and adjacent areas of natural gas from the Gulf fields in containers. Plans are being advanced for building a gas pipe-line 150 miles long from Poza Rica to the Federal District, and a pipe-line from the southern Vera Cruz fields, a distance of 303 km. across the Isthmus of Tehuantepec to Salina Cruz, which the Government proposes to recondition as the leading port of south-western Mexico.

Production and exports have been maintained at better levels than many observers expected, and though no official figures are issued, unofficial estimates which have been neither criticised nor denied in Government quarters, place the 1939 output at around 42,500,000 bls. compared with 38,200,000 bls. in 1938, and 46,689,684

bls. in 1937. Of last year's yield, about 4,800,000 bls. came from wells owned directly by the State, some 1,900,000 bls. from enterprises not effected by expropriation, and the remainder from wells of the expropriated companies.

MEXICAN OIL PRODUCTION

Fields.	1937.	1938. (thousands of barrels.)	1939.
Poza Rica	18,634	22,021	26,072
Northern	9,806	5,344	5,508
Southern	8,292	4,230	4,652
Isthmus	9,958	6,684	6,247
	46,690	38,279	42,479

EXPORTS BY COUNTRIES

	1937.	1938. (thousands of barrels.)	1939.
Germany	2,521	5,408	6,343
United States	6,856	2,683	5,456
Italy	186	350	4,750
United Kingdom	5,411	1,857	19
Other European Countries	1,118	1,416	437
Latin America	1,318	415	460
Netherlands West Indies	4,299	1,097	—
Japan	—	233	189
Other countries	1,355	426	431
	23,064	13,885	18,085
Bunkers	1,514	480	960
	24,578	14,365	19,045

Of the total exports, 72 per cent. in 1937 was in the form of manufactured products. In 1939 this percentage had fallen to 36, nearly two-thirds of the exports being in the form of crude.

It has been officially announced that the daily output is soon to be increased to at least 220,000 bls. of which 160,000 will be devoted to the home market, leaving the remainder for export; that $600,000 is being spent on drilling equipment; that eleven wells with a minimum daily output of 5,000 bls. each are being drilled, and that the drilling of nine more is to commence in June.

The technical staff is stated to be endeavouring to perfect a process for increasing gasoline octanage, and the Government is arranging for the early installation of a high-grade gasoline plant. Since 1938 Mexico has had to import aviation spirit, mainly from the United States, but a Government plant at Tacuba, a suburb of Mexico City, has begun the production of tetraethyl lead. Gasoline that is expected to result from these endeavours will be of two classes of octanage, one of from 59 to 65, and the other from 75 to 80. In this connection it is of interest to note that Mexico recently declared the patents of the Ethyl Gasoline Corporation to be void, and thus paved the way for the use of the ethyl fluid process without remuneration to the owners.

Mexico is now looking to Japan to replace the lost German market, and certain Japanese interests are actively acquiring Mexican production. A case in point is the completion of the programme of the Japanese-owned Cia. Petrolera Veracruzana S.A. to drill thirty wells to supply oil for Japan. These wells are to be situated in proven fields just south of Panuco near the Tamesi river.

In a confidential report some months ago, the managing director of Pemex is said to have complained of laxity, inefficiency and dishonesty among oilfields personnel. The report pointed out that between April and July 1938, directly following the seizure of the oil properties, the number of employees increased by 13·4 per cent., expenses rose from 4,273,218 pesos to 5,016,701 pesos monthly or nearly 18 per cent., and production fell from 570,000 to 420,000 cu. metres or 26 per cent., the refinery throughout also declined from 18,000 to 13,100 cu. metres daily or 27 per cent.

Reviewing the whole situation, the Government's chief claim to success has consisted in keeping the industry going despite loss of foreign executives and engineers. Initially the Government's representatives had every chance of success, having acquired a large and well-organised business as a going concern. There was no necessity to earn a return on capital investment because nothing was paid for the wells, pipe-lines, refineries, terminals and other facilities. Likewise there was no necessity to make provision for interest charges, depreciation or depletion ; and payment of royalties, ordinarily one of the heavy costs of oil-field operation, was suspended.

The only financial problem before the petroleum organisation was to produce enough revenue to meet operating expenses, its taxes, essential repairs and replacements.

Published statements from Mexican news sources have placed the losses of the petroleum organisation at figures ranging from 20 million to 80 million pesos.

Potash from Sea Water.—Although it has been found possible in many instances to recover the potash content of natural lake brines, the low percentage of potassium salts and the huge preponderance of sodium chloride in sea water have hitherto prevented direct recovery of potash from the latter source. Potash salts of varying degrees of purity can, however, be obtained from the bitterns produced in the evaporation of sea water for the production of common salt (see this BULLETIN, 1938, **36,** 326-334, and 1940, **38,** 109-111).

It is evident that a process for the separation of potash salts from the enormously larger amounts of sodium compounds present in sea water might be based very conveniently on a selective precipitant which would give an insoluble potassium compound while leaving the sodium salts in solution. Such a compound, as an analytical reagent for the detection of potassium on a very small scale, was proposed by Poluektov (*Mikrochemie,* 1934, **14,** 265-6),

the reagent being dipicrylamine or hexanitrodiphenylamine, which gives an insoluble orange-red potassium compound in a slightly alkaline solution.

The use of dipicrylamine has now been applied to the recovery of potash from sea water and a patent (E.P.22,025) has been taken out by the Norsk Hydro Elektrisk Kvaelstof A.S. (*Chem. Tr. J.*, 1940, **106**, 241). All the metals, except potassium, present in sea water form soluble compounds with the reagent. In the application of the process, one of the soluble salts of dipicrylamine, preferably the calcium compound, although the sodium, magnesium, or lithium salts may be used, in slightly alkaline solution, is added to sea water or other saline solution in quantity a little below that theoretically required to react with all the potassium present. The insoluble potassium salt is precipitated, filtered off and washed. The filtrate is acidified in order to precipitate any unused reagent, which is recovered.

The insoluble potassium dipicrylaminate is treated with an acid, preferably nitric acid, giving a solution of potassium nitrate and precipitating the dipicrylamine, which is recovered for re-use. Sulphuric, hydrochloric or acetic acids can also be used, while by the employment of carbon dioxide under pressure, potassium carbonate can be obtained.

An experimental plant is stated to have been erected at the Heroya works of the Norsk Hydro Elektrisk Company.

The preparation of the dipicrylamine reagent is carried out in two main stages. In the first place, aniline and aniline hydrochloride in equi-molecular proportions are heated in an autoclave, forming diphenylamine. The product is boiled with dilute hydrochloric acid, which removes the unchanged aniline and leaves the diphenylamine as the free base, which is separated and purified by distillation. As a laboratory reagent, dipicrylamine is prepared (Feigl, Spot Tests, Amsterdam, 1937) by dissolving diphenylamine in concentrated sulphuric acid and pouring this solution into fuming nitric acid. After the first violent reaction has subsided, the mixture is gently warmed to complete the nitration. It is then poured into ice-cold water, the dipicrylamine being precipitated, filtered off, washed and recrystallised from glacial acetic acid. This method of preparation is comparatively simple for an organic compound and the processes employed are well known. It is probable that a similar process is used to prepare dipicrylamine on a larger scale. At the present time the price of dipicrylamine, at any rate in this country, is very high, but it is made only on a very small scale as a laboratory reagent. The cost of manufacture on a commercial scale would undoubtedly be less and it would probably not be necessary to purify the commercial product to the same degree as is necessary for an analytical reagent. In the process described above, the reagent is, to a very large extent, recovered and used again, so that a continuous heavy expenditure for its replacement would not be necessary.

Selenium in Soils and Crops.—The problems presented by the occurrence of selenium in soils have already been the subject of notes in this BULLETIN (1936, **34**, 368; 1937, **35**, 196). The importance of this question arises partly from the direct effects of selenium on plants and even more from the influence of seleniferous vegetation on the health of the human and animal populations using it for food. Work on the various aspects of the problem has therefore been continued on an extensive scale, especially in the United States, where large areas, particularly of grazing land, are now known to be seleniferous. An account of this work, including some of the important conclusions which can be drawn from the available data, has been published in that country. ("Selenium Occurrence in Certain Soils in the United States with a Discussion of Related Topics: Third Report," by H. G. Byers, J. T. Miller, K. T. Williams and H. W. Lakin, *U.S. Dept. Agric., Tech. Bull. No.* 601, 1938.) A summary of this and other records may be of interest.

Selenium appears to be widely distributed in soils, no true soils containing colloids in any significant quantity having been found in which the presence of selenium cannot be demonstrated. (By the methods employed by Byers and his co-workers, it is stated that one part of selenium in 100 million parts of soil can be determined.) The amounts found range from less than 1 to over 80 parts per million. The selenium is believed to be derived mainly from the parent material of the soil, possibly supplemented by small quantities carried down from the air by rain. Although the presence of selenium in air has not been proved, it has been shown to occur in volcanic emanations.

Selenium may occur in the soil in various forms; as the element; replacing sulphur in minerals, especially pyrites; as a selenite, particularly basic ferric selenite; as a selenate, particularly calcium selenate; and as an organic selenium compound, the composition of which has not yet been determined. The availability of these various forms, and hence their absorption by plants and their toxicity, varies very widely, the basic iron selenite for instance being relatively insoluble and hence comparatively harmless as a soil constituent. The most readily available forms are believed to be the organic and the selenate compounds. The availability of selenium to plants is also influenced, in some cases, by the amount and the form of sulphur compounds present in the soil.

In the United States the soils which so far have been found to be definitely seleniferous are those derived from shales of the Cretaceous period, especially the Pierre, Niobrara, Greenhorn and Morrison formations and the corresponding formations under other local names. The distribution of selenium within the soil profile is extremely variable, and depends on a number of factors, the most important of which is thought to be the amount and nature of the colloidal constituents of the soil.

The occurrence of definitely seleniferous soils has now been

proved in nine of the States of the United States, although the individual areas vary enormously in extent, in total selenium content and in the toxicity of the vegetation growing on them.

The presence of selenium in Hawaii has also been shown. It is believed in this case that the selenium has been derived originally from volcanic emanations. Selenium has also been reported in Puerto Rico, but although the soils have been derived from Cretaceous shales, the amounts of selenium absorbed by plants growing on them are very small, and no toxic vegetation appears to occur. It has been shown ("'Non-toxic' Seleniferous Soils," by H. W. Lakin, K. T. Williams and H. G. Byers, *Industr. Engng. Chem., Industr. Ed.*, 1938, **30**, 599-600), that in both Hawaii and Puerto Rico, areas of highly seleniferous soils occur, which do not produce toxic vegetation. This emphasises the already ascertained fact that there is no quantitative relation between the total amount of selenium present in the soil and that absorbed by plants from it. This is evidently due to the varying degrees of availability of the different selenium compounds present in the soil.

A special case of seleniferous vegetation has been shown to exist in the Irapuato district of Mexico ("Selenium in Mexico," by H. G. Byers, *Industr. Engng. Chem., Industr. Ed.*, 1937, **29**, 1200-1202). An obscure disease, the symptoms of which resembled the "alkali" disease prevalent in certain parts of the United States and now known to be due to the selenium poisoning of stock, had been reported as having occurred for many years in this district. On investigation it was found that certain areas of soil and the crops grown on them were highly seleniferous. All these areas occurred in the flood plain of the Guanajuato River. The soils themselves are not naturally seleniferous, and the source of the selenium was traced to the waste products of the Guanajuato mines. In times of flood (about three times in ten years) silt from the waste dumps of the mines is washed away in large quantities and is later deposited on the river plain. The river waters which are used to some extent for irrigation also contain dissolved selenium believed to come from the same source. So far as is known at present, similar conditions do not exist elsewhere.

As mentioned above, selenium in quantities likely to produce toxic vegetation frequently occurs in North America in soils derived from Cretaceous shales. Large areas of such shales are found in the northern counties of Montana, and strata of the same type cover enormous areas in the provinces of Alberta and Saskatchewan in Canada. A preliminary reconnaissance survey of these areas has therefore been made, although they have not yet been examined in detail. ("Selenium in Canada," by H. G. Byers and H. W. Lakin, *Canad. J. Res.*, 1939, **17B**, 364.) It was found that seleniferous, and more or less toxic, vegetation is produced on soils derived from Cretaceous shales over very considerable areas in Alberta, even larger areas in Saskatchewan, and a much smaller

area in Manitoba. No estimate can yet be made of the exact extent of the areas involved, nor of the degree of toxicity of the vegetation. One very important observation, however, was that glacial soils may be toxic.

It has been found that the amount of selenium absorbed by different species of plant growing on the same soil varies enormously, some taking up very little, while others absorb large quantities, amounting in a few instances to about 1 per cent. of the weight of the dry plant. These selenium-loving plants can in fact be used to some extent as indicators of seleniferous soils. It has even been suggested that selenium in small quantity may be essential for the growth of certain species of plant. (" Selenium as a Stimulating and Possibly Essential Element for Certain Plants," by S. F. and H. M. Trelease, *Science*, 1938, **87**, 70-1.) If this is so, the essential nature of selenium appears to be limited to a very few species of higher plants. Some of these selenium-loving plants are able to concentrate selenium from relatively low proportions in the soil and it appears probable that they may thereby increase the selenium content of the top soil when they decay.

The toxicity of selenium compounds has been put to use in the development of selenium-containing insecticides, although it has been shown that the toxic effect varies widely with different kinds of insects. (" Immunity of Certain Insects to Selenium Poisoning," by S. F. and H. M. Trelease, *Science*, 1937, **85**, 590.) The compounds used seem to be mainly sulpho-selenides, prepared by dissolving selenium in solutions of potassium or other sulphides. Care must be taken that the plants treated do not absorb large quantities of selenium from the sprays used. (" Use of Selenium in Sprays for the Control of Mites on Citrus and Grapes," by W. M. Hoskins, A. M. Boyce and J. F. Lamiman, *Chem. Abstr.*, 1939, **33**, 7475 ; " Absorption of Selenium by Citrus and Grapes," by W. M. Hoskins, *Science*, 1938, **87**, 46-7.)

A further advance on this use has been to make the plant its own insecticide, especially in the case of cotton. (" A New Method of Control for Insect Pests of the Cotton Plant," by T. G. Mason and E. Phillis, *Empire Cotton Growing Rev.*, 1937, **14**, 308-9 ; " Possible New Methods for Controlling Insect Pests," by T. G. Mason and E. Phillis, *Trop. Agric.* (*Trinidad*), 1938, **15**, 45 ; " Observations on the Selenisation of Cotton under Field Conditions in Trinidad," by E. Phillis and T. G. Mason, *Empire Cotton Growing Rev.* 1938, **15**, 290-4.) Experiments were first made with cotton plants growing in sand and as these results appeared promising, field trials were carried out. Selenium in the form of sodium selenate was added to the soil in small doses over a period of six weeks, the total amount used being 24 lb. per acre as a maximum. It was found that bolls and seed from plants treated with 12 or 24 lb. of selenium per acre were strongly toxic to the cotton stainer and the pink bollworm, while these amounts were not sufficient to be

markedly toxic to the cotton plants. The residual sodium selenate was rapidly leached from the soil under the conditions prevailing in Trinidad, so that the treatment would have to be repeated each season. The cotton seed could not, of course, be used for stock feed and it would be necessary to take careful precautions in order to avoid any risk of poisoning. The amounts of selenium required would vary according to the soil and climatic conditions and would require very careful experiment and control, so that the method cannot be regarded as suitable for general adoption. It appears, however, to have possibilities, especially in the direction of growing, on a limited area, an early crop designed to trap the insects.

Fine Mineral Dusts as Insecticides.—Experiments have demonstrated that certain so-called "inert" materials, i.e. materials of no inherent toxicity, are, when used as dusts, definitely toxic to a number of insects infesting certain commercial products. A note was published in this BULLETIN (1937, **35**, 365) on recorded results obtained by the use of very finely ground silica dust for the control of the granary weevil in stored grain, and recently the results of tests on the application of six chemically inert materials for the control of the bean weevil have been published. ("Toxicity Studies of So-called 'Inert' Materials with the Bean Weevil, *Acanthoscelides obtectus* [Say]," by Shin Foon Chiu, *J. Econ. Entomol.*, 1939, **32**, 240-8).

The materials used were chosen because they are often employed as carriers for active insecticides such as nicotine, rotenone, arsenic and fluorine compounds, and included crystalline silica, amorphous silica, magnesium carbonate, bentonite, talc, and walnut-shell flour.

The crystalline silica was produced by the fine grinding of high-grade silica sand. The particles were rather irregular in shape, but with the exception of the extremely small ones, were mostly sharp edged. The particle sizes ranged from 1 to 147 microns in diameter, about 37 per cent. by weight being below 10 microns.

The amorphous silica was obtained by the grinding of diatoms. The particles were round and porous, and were all below 15 microns in diameter, 98 per cent. by weight consisting of particles below 10 microns.

The magnesium carbonate was of U.S.P. light grade, the particles being rounded and uniform in size, ranging from 1 to 3 microns in diameter.

The bentonite, which was a Wyoming product, was sifted through a 400-mesh sieve, and 90 per cent. of the particles were less than 10 microns in diameter. The particles were roughly spherical in shape.

The talc consisted of flat, irregular-shaped particles ranging from 3 to 9 microns in diameter.

The walnut-shell flour was prepared from Californian shells, and was sifted through a 200-mesh sieve, the particle sizes ranging from

1 to 60 microns in diameter. About 35 per cent. of the particles were less than 6 microns in diameter and their shape was roughly spherical.

All the materials were thoroughly dried in an oven at 110° C. before being used in the tests.

The insects used were bean weevils and the tests were carried out in an insectary, all the environmental conditions such as lighting, humidity and temperature, being carefully controlled, so that the dust used should be the only variable. Each material was dusted on to a definite number of insects for each test. It was found that the average amount of dust which actually remained adhering to each insect varied considerably according to the nature of the dust.

The results of the tests showed that bentonite was the most active agent, magnesium carbonate, crystalline silica, amorphous silica and talc being less effective in that order. Walnut-shell flour appeared to have no toxic effects whatever.

A further series of tests was made, using crystalline silica ground to four different degrees of fineness. It was demonstrated that the toxicity increased as the average size of the particles decreased.

Observations of respiration and loss of weight of the treated insects indicated that the former was not affected, the toxic effect being due to withdrawal of water from the tissues of the insect by the closely adherent dust, so that death was caused by desiccation.

Materials of this kind are evidently toxic only to certain types of insect and under certain conditions. Jary and Austin ("Investigations on Insect Pests of *Brassica* Seed Crops in Romney Marsh," *J. Southeastern Agric. Coll., Wye,* 1939, No. 44, 73) found that colloidal silica dust (the fineness of which is not stated) did not give consistently satisfactory control of the beetle *Meligethes æneus* infesting certain types of *Brassicæ*, under either field or insectary conditions.

Correlating Strata by Insoluble Residues.—Semi-mechanical methods of strata correlation where fossil or precise lithological evidence are lacking have become increasingly popular in America, and though the first work was probably done in this country, it was the research of Trager on oilwell cuttings and Lamar on the Chester limestones, Illinois, which established a definite technique.

In the United Kingdom a study has recently been made of the indeterminate limestones at Halkyn in North Wales, and some striking results have been obtained by K. Khosrovani (*Bull. Inst. Min. Met.*, 1940, No. 424, pp. 1-19).

The limestones in question are of Carboniferous age, rest unconformably on Silurian strata, and consist of the following groups:

1. *White Limestone*, lying unconformably on the Silurian; lower 400 ft. dark brown colour, remaining 1,500 ft. massive white in colour.

2. *Intermediate Limestone*, 80-100 ft. thick; conformable on White Limestone; overlain by shale band (Lower Shale); light to very dark in colour; fine, crystalline texture.
3. *Black Limestone*, uppermost division of limestones; overlain by Millstone Grit; 400 ft. thick; variable in character; first 80 ft. separated from upper part by shale band (Upper Shale), medium light colour, fairly massive; upper part a shaly and argillaceous rock, changing at top to a light and more siliceous character.

In the mine, differentiation between the rocks of the above horizons in the hand specimen is difficult, and particularly so when headings are made in virgin ground, or when successive displacements are encountered.

To establish the characteristics of each stratum, samples were taken in the mine shafts at the top, middle and bottom of beds up to 5 ft. thick, and at a 4 to 5 ft. interval in thicker strata. These samples, each weighing from 200 to 300 gm., were carefully described in the hand specimen, chips were retained for thin-sectioning, and the remainder crushed to give a maximum quantity of 10 mesh sieve grade. Then 25 gm. of each was dissolved in 50 cc. of analytical hydrochloric acid plus 50 cc. water, excess of acid being added until effervescence ceased. The whole was then diluted with water, and the residue allowed to settle.

The next step was to dry the residues, weigh them, and finally add water again and remove as much of the fine silt as possible. The choice of a 25 gm. sample permits of a rapid conversion to a percentage basis.

The final samples were then examined microscopically. Results of a definitely correlative value were obtained for the White, Intermediate and certain horizons in the Black Limestone, but the shales presented problems requiring modifications of the technique to arrive at satisfactory conclusions.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

THE GEOLOGY OF CHINA. By J. S. Lee, D.Sc. Pp. xv + 528, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Thomas Murby & Co., 1939.) Price 31*s*. 6*d*.

Although the study of the geology of China has received a fair measure of attention both from official and private workers, few, if any, general textbooks suitable for the student who wants a comprehensive survey rather than details of research have hitherto been published.

Professor Lee's volume on the geology of China, which is based

on a series of lectures given in British universities, is, therefore, to be welcomed as filling this gap, particularly in view of the difficulties which have attended the production of the book in its later stages.

In common with nearly all text-books dealing with the geology of a particular country, one finds on opening the pages that the subject-matter refers almost entirely to the structural and stratigraphical geology of the country. This omission of petrology, mineralogy, mineral deposits, etc., from the connotation of the word geology is, as Dr. W. R. Jones has pointed out, an entirely un-English usage of the term.

Under this conveniently brief title, therefore, Dr. Lee deals almost exclusively with the tectonics and stratigraphy of China, an area so large, of course, that separate volumes would be required to cope adequately with its economic geology, petrogenesis, etc.

In order to approach the study of the stratigraphy of the country on a logical basis, it has been necessary to describe the tectonics of the country and the natural provinces into which it falls as a result of the major structural features. The first of the two parts into which this volume is divided deals, therefore, in eight chapters with natural provinces, the ancient floor of China, marine transgressions and epochs of tectonic movement, post-palæozoic formations and the Yenshan movements, Cathaysian geosynclines and geanticlines, east-west tectonic zones, shear-forms, and with tectonic types and their related earth movement. The two chapters of the second part then proceed to deal with the Pleistocene climate of China and its regional stratigraphy, the latter information, after introductory remarks, being presented in tabular form.

The volume is well illustrated, and another excellent feature, for those who wish to go into greater detail, is the addition of selected bibliographies at the end of each chapter.

PUBLICATIONS DU BUREAU D'ETUDES GEOLOGIQUES ET MINIERES COLONIALES. No. 14. Notes de Pétrographie par J. Durand. Pp. 81, 10 × 6¼. (Paris: Bureau d'Etudes Géologiques et Minières Coloniales, 1939.) Price 20 francs.

The progress of petrography has not been one characterised by increasing clarity, but rather the reverse, until to-day the fashion would appear to be for stranger rock names and more incomprehensible classifications. It is, therefore, with some relief that one opens M. Durand's little book and finds not only an interesting survey of the more recent petrographical developments, but also some criticisms of the incompatible pronouncements which have been made from time to time by even the most illustrious petrologists.

In such a short volume one cannot expect to find penetrating studies of all the aspects of petrography and petrology, nevertheless it has been possible to treat with clarity and point the subjects

of rock nomenclature, chemical composition, the origin of eruptive rocks, batholithic intrusions, magmatic differentiation, magmatic assimilation, petrological structures, the origin of granites, and metamorphism.

M. Durand attempts no original contributions to petrological scientific thought, but provides an invaluable précis of the works of such prominent writers as Tröger, Alling, Niggli, Michel-Lévy, Bowen, Fenner, Cloos, Daly, and Sander, as well as many others. "Notes de Pétrographie" is an excellent sketch and introduction to the publications of these geologists of which a bibliography of some 113 items is furnished.

THE QUALITY OF COKE. By R. A. Mott, D.Sc., F.I.C., and R. V. Wheeler, D.Sc., F.I.C. Pp. xxxv + 464, 9¾ × 6¼. (London: Chapman & Hall, Ltd., 1939.) Price 36s.

The second report of the Midland Coke Research Committee marks a period in scientific work not only on the coking of coal, but on coal chemistry generally. It is greatly to be regretted that it is the last publication of the late Dr. Wheeler who was for many years an eminent figure in British fuel technology.

In addition to accounts of the research carried out at Sheffield in the period 1930-37, this volume also covers many aspects of coal research which have been the special fields of other workers and thus makes a more general appeal than might otherwise be the case.

The report is in four parts devoted respectively to an introduction to commercial coke, its standards, stages of formation, the characteristics of coking coals and influence of carbonising conditions; a detailed study of coke characteristics, sampling, and analysis; the mode and mechanism of coke formation; and the final one to methods of improving the quality of coke.

Apart from the physical qualities of coke such as size, density, porosity, hardness and abradability, and the thermal characteristic, "reactivity", which are all admirably treated, perhaps the most interesting section of the earlier parts of the book is the chapter (XII) on the specification of coke. Here it might be expected that some definite types had been arrived at, but the authors at once point out that a rigid specification for metallurgical coke is not possible owing to variations in classes of iron ore and rates of furnace drive. What is discussed, however, is the desirability of determining some standard scheme for the sale of coke to specification, and the standard analysis tentatively advanced is as follows: moisture over 4·0 and under 5·5 per cent.; ash over 9·0 and under 10 per cent.; 1½ in. shatter index of hardness, over 75, under 80, with a qualification that the ½ in. index should be not less than 96. Bonuses or penalties are suggested for superior or inferior grades of coke supplied, and methods of assessing the quality of the coke are proposed.

Attention also naturally centres on the last part of the report,

devoted to the improvement of coke quality. The authors modify their earlier opinion (Coke for Blast Furnaces, 1930) as to the effect of fine-grinding of coal on the hardness of the resultant coke, and conclude that for coals relatively high in durain or shale content finer grinding is necessary to overcome the lack of swelling power of both, and to eliminate as much of the latter as possible in the cleaning process. Coke-hardness may be further improved by adhering to the practice of top-charging of ovens rather than cake-charging, when, despite a lower bulk density of charge in each oven, a greater output is obtained by reason of the shorter coking period necessary. The effects of variations in rate of heating are also discussed, and the concluding chapter is devoted to the complicated subject of blending coals for coking as applied especially to Midland seams.

The report, which has a profusion of plates and diagrams and both a name and subject index, may be described not so much as an account of research work done under the aegis of the Midland Coke Research Committee as a quasi text-book on the chemical aspect of coke production. An advantage would have been gained if the research work for that organisation could have been clearly demarcated from the activities and achievements of other bodies and individual workers.

MOTOR BENZOLE. ITS PRODUCTION AND USE. By W. H. Hoffert, M.A., B.Sc., F.I.C., and G. Claxton, M.Sc. Second Edition. Pp. xxv + 933, 9 × 6. (London: The National Benzole Association, 1938.)

The first edition of this book appeared in 1931, but the many recent advances in the production and refining of motor benzole, together with developments in the design of internal combustion engines, have now necessitated a thorough revision.

The isolation of benzole from the products of coal carbonisation is described in detail and chapters are also included on the production of benzole from gaseous hydrocarbons and the preparation of aromatic hydrocarbons by cracking and hydrogenation processes.

The design and operation of plants for the extraction of benzole from coal-gas by the wash-oil and adsorption processes is considered from the theoretical and practical aspects, together with the economic factors involved.

The second half of the book deals with the composition, refining and properties of various benzoles. A description of the use of blends of benzole as motor fuels, with especial reference to the effect upon the "knock rating" of the fuel, is included. Theories which have been put forward to explain the phenomenon of "knocking" in the internal combustion engine and practical methods of determining the "knock rating" of motor fuels are described.

The final chapters deal with the storage and handling of benzole, with various specifications for motor benzole and with tests and methods of analysis. A collection of useful tables and data is appended.

The problem of increasing the production of benzole is of especial interest at the present time and the book will prove of great interest to those engaged in this important industry, to designers of internal combustion engines, and, although not primarily intended for them, to workers in the numerous chemical industries in which benzole is an essential raw material.

ENGINEERING MATERIALS. By Alfred H. White. Pp. x + 547, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1939.) Price 30*s*.

This is intended primarily as a text-book for engineering students who have had a first course in chemistry, but the materials dealt with cover such a wide range that the work will probably be of interest to a much wider circle of readers. The materials covered include, among others, iron and steel and their methods of manufacture; the base metals and their alloys; the light metals and their alloys; rocks and their decomposition products; fused silicates; lime, gypsum, and magnesium oxychloride products; the various silicate cements; fuels and combustion; water and its industrial utilisation; organic preservation materials and protective coatings; plastics and related products.

Half of the book is given up to iron and steels and the effects on them of various treatments and alloying materials. Altogether there is a wealth of information succinctly given and well illustrated. Each chapter concludes with a useful bibliography, though of course the bulk of the references are to American literature.

BIBLIOGRAPHY

Comprising the more important reports, articles, etc., contained in mineral publications received in the Library of the Imperial Institute during the three months February-April 1940.

The publications issued by the Governments of the Colonies and Protectorates can be obtained from or through the Crown Agents for the Colonies, 4 Millbank, Westminster, S.W.1. Applications for Dominion and Indian Government publications may be made to the Offices of the High Commissioners or Agents-General in London.

OFFICIAL ANNUAL REPORTS

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EXHIBITION GALLERIES, FILM LIBRARIES AND CINEMA

NOTES

Exhibition Galleries.—The Galleries were reopened to the general public during the Easter holiday period, March 23 to 25 inclusive, for the first time since the declaration of War, a suitable air-raid shelter having been made available for the use of visitors. In view of the restricted hours of opening, namely from 2 p.m. to 5 p.m. each day, the attendance of over 2,000, although below the usual figure, may be considered satisfactory; and it is noteworthy that the visitors, mostly adults, took a keen interest in the exhibits of food products and munitions materials in the various Empire courts, this interest being no doubt stimulated by the frequent references to these products in the daily press and in broadcast talks.

The Galleries have been subsequently opened to the general public on Saturday and Sunday afternoons, whilst the usual facilities for visits by conducted parties from schools have been continued.

The addition to the Indian Court of the model of the Second All-India Cattle Show was referred to in the last issue of the BULLETIN. Although it is well known that cattle are extensively used in India for draught and milking purposes, the unique position held by some of the improved Indian breeds in other tropical countries has not been generally appreciated. This fact is, therefore, brought to light in the descriptive label attached to the model which reads as follows:

Indian Cattle at the All-India Cattle Show

" Cattle in India may broadly be classified into those bred for draught purposes, for milking, or, to a lesser extent, for beef.

" There are some 200,000,000 cattle in India of many different breeds, some of which are greatly valued in other tropical countries for their hardihood, economy in upkeep, and for their high power of resistance to heat and to many of the diseases to which western breeds frequently succumb when transferred to the tropics.

" Indian cattle are exported to Formosa, the Philippines, Java, the Straits Settlements, Ceylon, Iraq, East Africa, the West Indies, and South and Central America, and the Southern States of the U.S.A.

" In order to give encouragement to breeders of high-class stock both for local distribution and for export, the first All-India Cattle Show was organised as an experiment by the Imperial Council of Agricultural Research, and was held at New Delhi in February 1938.

" The success was instantaneous, some 500 animals of twenty-three different breeds being exhibited. The interest aroused and the popularity achieved were such that it was decided to make the cattle show an annual event. To this end a society known as the All-India Cattle Show Society has since been constituted under the patronage of His Excellency the Viceroy, and many of the ruling Princes of India.

" This model, to a scale of one-sixteenth the actual size, portrays a portion of the Second All-India Cattle Show, held at New Delhi in 1939."

The four show-cases of Burma padauk originally provided for the purpose of exhibiting agricultural products in the Burma Pavilion at the Empire Exhibition, Glasgow, have been reconstructed in the Imperial Institute workshops for use in the Burma Court. One case has been advantageously adapted for the story exhibit of Burma jade and amber, and the other has been used for the display of a pair of ivory tusks and some fine examples of Burmese ivory carving. The remaining two cases are reserved respectively for a display of Burma rubies and other precious and semi-precious stones, and for an exhibit representing the tung oil industry in Burma.

With the closing of the Ceylon House in London several exhibits of Ceylon produce, photographs, posters, pamphlets, lantern slides, etc., have been transferred to the Imperial Institute. A collection of graded trade samples of plumbago has also been taken over at the express wish of Messrs. H. L. de Mel & Co. of Ceylon, with a view to supplementing the existing plumbago exhibit in the Ceylon Court. A scale model of an up-to-date plumbago mine prepared by the Survey Department, Ceylon, complete with a key map, has also been transferred. This model, after being renovated, has been encased in a suitable cabinet constructed in the Imperial Institute workshops and painted with graphite paint, and is now on view in the Ceylon Court. The descriptive label for the model reads as follows:

A Plumbago Mine in Ceylon

(Plumbago, graphite or black lead)

" This model shows a section of a typical plumbago mine in Ceylon, where plumbago deposits have been worked for nearly a century.

" In this mine two main shafts, fitted with cages hauled by steam power, run from the top of the mine to the bottom. These enable a natural ventilation to be maintained and also provide a double exit for the men in an emergency.

"There are several levels each connected by two shafts—one being a ladderway for the men, and the other, fitted with hoists, is used for bringing up the plumbago from level to level.

"Inside the mine the work of exploitation and prospecting is conducted by means of stopes, drifts, winzes and raises. From the working faces the plumbago is raised by windlass or lowered by chutes into main tunnels fitted with tramways and hand-pushed trollies.

"A large mine provides work for about a thousand people, women being employed in "curing" the plumbago on the surface. Generally a small town grows up round a mine, and all amenities for the labour force, such as living quarters, stores, reading rooms and recreation grounds, are provided.

"Ceylon plumbago is noted for its purity, and the different forms in which it occurs include 'flake graphite' and 'amorphous graphite.' The exports from Ceylon go chiefly to Japan, the U.S.A. and the United Kingdom."

Funds for the construction of an up-to-date diorama of Freetown Harbour, to replace the existing one in the Sierra Leone Court, have been generously donated by Messrs. Elder Dempster Lines, Ltd., of Liverpool. The preliminary sketch for this diorama has been approved, and the constructional work is now in hand in the Imperial Institute studio.

From a negative kindly loaned by Messrs. Dorman, Long & Co., Ltd., a transparency of the Otto Beit Bridge has been made as a companion picture to that showing the Birchenough Bridge in a window of the Southern Rhodesia Court.

A series of photographs to tell the story of Uganda mahogany has been received from the Conservator of Forests, Uganda. Photographs of scenes in Uganda and Kenya, prepared from negatives kindly loaned by Mr. H. J. R. Way, and others showing locust swarms in Tanganyika, prepared from negatives kindly loaned by Dr. D. R. Grantham, have been added to the East African Court.

Additional photographs of scenes in Nigeria and the Gold Coast have been obtained and added to the travelogue of West Africa.

To the Canadian Court has been added a bronze statuette of Captain George Vancouver, the founder of the city of Vancouver, British Columbia. This addition to the number of statuettes of men prominent in the history of Empire countries has been acquired as a result of a special grant provided for the purpose by the Government of British Columbia.

The statuette is a replica of the original study model of Mr. Charles Marega's statue of the explorer which stands just outside the City Hall at Vancouver, the unveiling of which by the Lord Mayor of London took place in August, 1936.

Mounted on an ebonized pedestal the bronze has been placed in the Canadian Court near the East Entrance and adjacent to the

diorama of Vancouver city where it serves as opposite number to the statuette of General Wolfe which occupies the other end of the Court near the diorama of Quebec (see Plate VI).

The label attached to the pedestal of the statuette reads as follows:

Captain Vancouver
(1758-1798)
Explorer and Navigator

"Born at King's Lynn, Norfolk, in 1758, George Vancouver entered the navy at the age of 13 and served under Captain Cook during his second and third voyages. After service in the West Indies, Vancouver was selected to command an expedition to the South Seas, but before preparations had been completed trouble broke out between England and Spain over the action of Spaniards at Nootka Sound, in April 1789. The projected exploration of the South Seas was therefore postponed and Vancouver was ordered to Nootka Sound, formally to take back territory seized by the Spaniards, to make an accurate survey of the coast northwards from 30° N. Lat. and to search for any waterway eastwards to the Atlantic.

"This expedition sailed from Falmouth on April 1, 1791, *via* the Cape of Good Hope, Australia and New Zealand and reached Cape Flattery on April 29, 1792. Vancouver entered the Strait of San Juan de Fuca, charted the Puget Sound, which he named after his second lieutenant, and, continuing northwards, surveyed the Burrard Inlet and Howe Sound. On June 22 he met with two small Spanish ships near Gray's Point which were engaged on a survey of the channels. Vancouver obtained charts from them which facilitated his voyage northwards to Cape Scott, which he rounded on August 25, reaching Nootka two days later. Here he met Senor Quadra, the Spanish commander, and, acting in amity, they agreed to await further instructions from their respective Governments regarding the transfer of territory, a question finally settled at Madrid on January 11, 1794.

"For the time being the Island which had just been navigated was named 'Quadra and Vancouver Island' and after handing over Quadra sailed for Mexico on September 22, 1792, whilst Vancouver left on October 12 for the Sandwich Islands where he spent the winter.

"Returning the following spring, Vancouver charted the coast during 1793 till October, when he again went to the Sandwich Islands for a time. In the spring of 1794 he visited Kadiak Island and the Alaskan coast, and proved conclusively that there was no navigable channel giving access to the Atlantic.

"Vancouver returned to England by Cape Horn, arriving in the Thames on October 20, 1795, and settled down to write an account of his voyages, but he died at Petersham, Surrey, on May

PLATE VI.

Captain George Vancouver.

A Statuette in the Canada Court of the Exhibition Galleries of the Imperial Institute.

[*facing page* 274.

PLATE VII.

A BERMUDA SEA GARDEN. A GLIMPSE OF THE UNDER-SEA LIFE OF THE CORAL REEF.

Reproduced from a Diorama in the Exhibition Galleries of the Imperial Institute.

[Facing page 275.]

10, 1798, just before his book was published. He is buried in the churchyard of the old church at Petersham."

To the Bermuda Court has been added a diorama depicting a very realistic submarine view of the sea gardens which are such a delightful and characteristic feature of this island colony. This attractive addition to the Court has been rendered possible through the generosity of the Bermuda Trade Development Board in providing the necessary funds. It was constructed in the Imperial Institute studio by Mr. Ernest Whatley. The accompanying illustration (Plate VII) gives a very faithful impression of the artist's treatment of the subject, but does not convey the vivid yet subtle colouring which is the main charm of the original.

The descriptive label attached to the diorama is as follows:

A Bermuda Sea Garden

A glimpse of the under-sea life of the coral reef

" One of the great attractions of Bermuda is the submarine life in and around the coral reefs which surround the islands. A delightful pastime for holiday-makers in Bermuda is to go out in boats fitted underneath with glass panels through which the coral reefs and their denizens may be studied.

" This diorama gives a glimpse of some of the wonders of under-sea life which would meet the eye from one of these boats, or through the window of a diver's helmet.

" [1]A writer, who is also a diver, has described his impressions of such a scene as follows: ' The fish crowded round me, hundreds of them. There were Blue Angels and Yellow Grunts, Sergeant Majors, Trigger Fish and Porgies, Four Eyes and Demoiselles. The Angels came and looked through the window of the helmet, the Porgies and Slippery Dicks swam between my legs, and the Sergeant Majors nibbled at my shoulders. I often had to wave my arms to drive away these insistent seekers after food and knowledge. In and out through the crevices of the coral and under the over-hanging brainstones they came and went, moving without apparent effort, while the blue and gold clumps of iridescent weed swayed with them in the swell . . . Near St. Katherine's Point the soft branching gorgonias predominate, covering the sea floor with their fan-like growths, further out to sea rugged rings of hard coral rise up from deeper waters . . . I could see in all directions romantic alleyways opening out to the sea beyond; the water was clearer than in the harbour, and all life sparkled with iridescence.' ".

In the New Zealand Court, in line with the new fruit exhibit described in the last number of this BULLETIN, two scenic backgrounds have now been installed as an aid to the representation of the dairy and the meat and wool industries. The scene for the

[1] Robert Gibbings in *Blue Angels and Whales*.

dairying exhibit shows cattle grazing on good pasture land rising in the distance to mountain heights. The cattle represented are of Jersey, Freisian and Shorthorn breeds. A five-wired fence separates the cattle pasturage from a winding road on the other side of which is depicted a piggery. In the foreground of the scene, where the pasture has grown rank, are field flowers. On each side of the scene a separate compartment of the showcase has been used to exhibit realistic models of primary products. On the left, starting with a bottle of fresh milk, are shown dried milk, cheeses and a case of butter as its derivatives. In the compartment on the right are a side of bacon and tins of preserved meats.

The scene with the meat and wool exhibit shows flocks of sheep being concentrated from rising hill land by drovers and their dogs for the shearing. A log bridge in the foreground is being crossed by the leading sheep while others are still scattered on the heights. Snow-capped mountains appear in the distance, and on the left is a glimpse of the sea coast and of vessels, one of which is H.M.S. *Achilles* of the New Zealand Squadron, and famous for her action in the Battle of the Plate. The separate compartments on each side of this exhibit show, on the left, a sheep carcase and a wooled sheep skin, and on the right a product story which starts with the wool sortings and goes on through the stages of wool in the grease, scoured wool and carded wool, concluding with samples of blankets and rugs of New Zealand manufacture.

An illuminated dioramic model of the Port of Singapore, the commercial gateway to Malaya and the transhipment centre of the east, has been installed in the British Malaya Court. This model is the property of the Singapore Harbour Board, by whom it has been lent for exhibition in the Court. The model shows very clearly the numerous wharves and dry docks under the control of the Harbour Board, the scene centring upon the Empire dock, which is over 24 acres in extent, and has a quayage of 3,522 ft. and a depth of 30 ft. at low water. Behind this dock can be seen the F.M.S. Railway terminus, while in front of it is the Tanjong Pagar Main Wharf. Conspicuous in the scene are the numerous stacks of coal, also tanks for storage of fuel and diesel oil, for bunkering vessels. On the extreme right can be distinguished the civil aerodrome and in the sky is an approaching Imperial Airways flying boat. Other points of interest in the model are Fort Canning with its signal station; the Fullerton Building containing the Port offices and overlooking the Inner Harbour; the mole, a mile long, protecting the Inner Harbour and the Telok Ayer Basin from the north-east monsoon; the Singapore Yacht Club with jetty, and, close by, the sunken hulks protecting the East Lagoon with its yachts; and Mount Faber with its observatory, night signal station and flagstaff. Numerous vessels belonging to well-known lines are shown at the wharves, and some are undergoing repairs in the dry docks. Leaving the harbour is the C.P.R. liner *Empress of Britain*.

A collection of mineral specimens has been supplied to the Overseas Representative of the Department of Mines at South Africa House, for use as a permanent exhibit at the South African Legation in Paris. Included in this collection are examples of the following: gold, tin, vanadium, platinum, antimony, copper, silver-lead, manganese, iron, asbestos, diamondiferous blue ground, mica, fluorspar, granite, torbanite, tiger's eye and marble, all from the Union of South Africa, and rutile and Iceland spar from South West Africa.

A collection of products from Ceylon, British North Borneo, West Africa and Zanzibar has been loaned to the Department of Overseas Trade for display in the Colonial Hall at the World's Fair in New York which opened on May 11.

Assistance has been rendered by the loan of photographs from the collections for the making of lantern slides to illustrate a series of lectures on the Colonial Empire which have been prepared from funds granted by the late Colonial Empire Marketing Board.

Picture Postcards.—Four new sets of picture cards have been prepared by the collections staff and issued as additions to the Imperial Institute series of cards illustrating industries in Empire countries. The new sets deal with New Zealand industries and are as follows:

(1) Dairy Farming in New Zealand;

(2) The Butter Industry of New Zealand;

(3) The Cheese Industry of New Zealand; and

(4) Apple Growing in New Zealand.

A descriptive leaflet accompanies each set of six pictures, and each leaflet includes an outline map showing the chief areas with which the industry is concerned.

The text of the leaflets is as follows:

Dairy Farming in New Zealand

" Dairying is the most important industry in New Zealand, this country being the greatest exporter of dairy produce in the world.

" When the first settlers arrived from the home country they found a good dairying climate and ample pasture lands, but no indigenous cattle. To-day the dairy cattle number about two millions. These are largely concentrated on the lower lands of the North Island where the bulk of the butter is produced.

" The pastures are sown with European grasses and clovers which grow all the year round, and make roots and other crops unimportant as additional feed; and the mild winters do away generally with the need for stall-feeding the cattle. Nauru Island in the Pacific yields a cheap and suitable phosphate manure for the pastures.

"The dairying industry is one of small farms and large central factories. The farmer supplies the milk or cream and the factory produces the butter, cheese, dried and preserved milk or casein. Casein is the source of one of the plastic materials for moulded ware. These products, especially butter and cheese, are exported in very large quantities to the United Kingdom.

"The demand for exports is the mainstay of the farmer, for the people of New Zealand alone could consume only a small proportion of the total output of dairy produce.

"1. *Dairy Farm Homestead.*—The homestead of the small family freehold dairy farm of New Zealand is usually of the bungalow type with a verandah. The farms are generally of about 120 acres with a herd of about 45 cattle, though smaller farms are common.

"2. *Jersey Cow.*—This is the most numerous and most important dairy breed in New Zealand. The Jersey cow is small in size and does not produce a large bulk of milk but a greater number can be pastured to the acre than with heavier breeds, and the milk is rich in butter-fat and is specially valued for butter manufacture.

"3. *Friesian Cow.*—This breed is of a heavy type and is a good yielder of milk. The milk is, however, not so rich in butter-fat and is consequently more suitable for the production of cheese than butter.

"4. *Shorthorn Cow.*—Another heavy breed, intermediate between the Jersey and the Friesian cows in quantity of milk and butter-fat content. As with the Friesian this cow is suited to cheese production and is more suited to the colder climate of the South Island of New Zealand than is the Jersey cow.

"5. *Milking by Machinery.*—The development of suitable water-power sites has provided cheap electricity, and electrically worked milking machines, reproducing the pulsating suction natural to the calf, have become almost universal in the dairying districts of New Zealand. Each cow is tied by the leg during the milking and on release passes forward through a doorway into the open. The concrete floor with its run-ways ensures cleanliness.

"6. *Delivering Milk at Dairy Factory.*—Milk, or the mechanically separated cream, is sent from the farms to the dairy factories for the manufacture of butter and cheese. The motor wagon is now replacing the horse-drawn cart especially in the North Island where the cream may come from a considerable distance to the factory."

The Butter Industry of New Zealand

"New Zealand, in early years, produced butter chiefly for her own requirements, though considerable quantities were salted and sent to England and Australia in casks. The introduction of refrigeration, which enabled butter to be exported to Britain fresh, greatly extended the market and the dairy industry rapidly grew. To-day New Zealand is among the world's leading butter exporting countries. Her annual exportation is between 130,000 and 140,000 tons. Almost all of it comes to the United Kingdom.

"More than half of the cows in the Dominion are milked by machinery, and home separation of the cream from the milk has largely taken the place of the delivery of the milk to the butter

factory. The carriage of cream to the factory instead of milk is less costly, because the bulk is less.

"The butter factories are mainly situated in the North Island chiefly in the Auckland province.

"The 'skimmed' milk separated from the cream and the buttermilk eliminated in the churning process are utilised in the feeding of pigs.

"1. *Milking Time.*—A mixed herd. Of the different breeds in New Zealand the Jersey Cow is mainly used as a source of milk for butter-making. Although of light-weight this cow reaches maturity early and produces milk richer in butter-fat than the heavier breeds.

"2. *Separating Cream from Milk.*—The milk is put into the cream separator, a machine worked by an electric motor. In this separator the heavier skimmed milk is separated and impelled to the circumference whilst the cream flows out through a separate channel and passes over a coiled brine cooler into a container.

"3. *Churning the Cream into Butter.*—On arrival at the butter factory the cream is pasteurised, and after being cooled again is passed into churns. Here is one of the large central butter making factories common in the North Island. Some long barrel churns with a side delivery of butter can be seen.

"4. *Withdrawing Butter from the Churns.*—The cream is mechanically churned into butter which is worked free from butter-milk within the churn. This churn has an end delivery of some 3,600 lb. of finished butter ready for packing.

"5. *Grading Butter before Export.*—The butter from the churn is passed by machinery through an opening of the same width and depth as the butter box and is cut off at the correct length for the box by wires. It is then weighed and wrapped in parchment and the butter box is slipped over it. Finally the butter is examined for quality and weight by expert graders before shipment.

"6. *Loading New Zealand Butter for Export.*—The boxes of butter, each bearing the New Zealand fern-leaf design indicating the national brand and weighing 56 lb. are being loaded on to a ship at Wellington for export chiefly *via* Panama to the United Kingdom. A temperature of from 10° to 15° F. is maintained during the voyage, which takes normally about 36 days."

The Cheese Industry of New Zealand

The important areas for cheese production in New Zealand are in the Taranaki district in the south of the North Island and in the Southland province of the South Island. The heavy-weight Friesian and Shorthorn breeds of dairy cattle with their abundant yields of milk are the mainstay of the industry.

It is calculated that one gallon of milk is required to produce about one pound of cheese. When milk turns sour, a curd is formed which is a crude form of cheese. Under the controlled methods of the factory the curd, which is manufactured into cheese, is formed from milk with the aid of rennet obtained from the young calf. Cheese is especially rich in fat and protein, and as a body-building power it is better and cheaper than meat.

" The dairy products of New Zealand, butter and cheese, together constitute her richest exports, and in normal times the export of cheese from New Zealand is greater than that of any other country in the world. The industry is a co-operative one. The government gives the farmers a guaranteed price, purchases the export output and sells it to accredited agents in Great Britain and elsewhere, chiefly Great Britain. Before export the finished product is examined by expert graders who examine the cheeses for flavour, texture and moisture, and ensure that none below the national standard leaves the country.

" 1. *Pastoral Country in Central Otago.*—This scene shows pastoral country in central Otago in the South Island. In the centre foreground is a cow of the heavy-weight Friesian breed. Both this and the Shorthorn breed are used largely in the production of milk for cheese making.

" 2. *A Cheese Factory.*—The cheese factories of New Zealand tend to be smaller in size than the butter factories. They require whole and fresh milk. Butter is made in some cheese factories from whey, a by-product of cheese making. There are a number of ' dual ' factories in New Zealand so equipped that they can make either cheese or butter.

" 3. *Receiving Milk at Cheese Factory.*—On arrival at the factory the milk is tested for butter-fat content and weighed.

" 4. *Pasteurising and Cooling Plant.*—The milk is pasteurised or sterilised by exposing it to a high temperature, and is then passed over a tubular cooler. This process ensures for the cheese a uniformity of quality and a mild flavour.

" 5. *Cheese Vats and Presses.*—The milk in 1,000 gallon vats is heated and mechanically stirred to obtain uniformity of composition. After being left to ripen to a suitable flavour, a curd is formed by the addition of rennet. The curd when set firm is cut up, allowing the fluid whey to be drawn off. After allowing time for the curd to dry and ripen it is broken up and salt is added to impart flavour and to act as a preservative. It is then heated and transferred in hoops with loose tops and bottoms to the horizontal presses seen in the foreground, and the resulting cheeses are prepared for the market by bandaging and ripening.

" 6. *Weighing Cheeses for Export.*—The cheeses are checked for weight and crated in pairs, each cheese weighing 80 lb. The crates, which are twelve-sided and ensure good ventilation, are branded with the New Zealand fern-leaf design. About 63 per cent. of the cheese imported annually into the United Kingdom in normal times comes from New Zealand."

Apple Growing in New Zealand

" The early missionaries introduced fruit trees into New Zealand and planted orchards near the mission stations. As the settlements extended fruit-growing increased. Plenty of cheap land, too poor for agricultural crops, was found to be suitable for apples and this has resulted in large areas being planted.

" Production soon exceeded the local demands, and an overseas market for the surplus was therefore sought. The first trial shipment to London took place in 1892. Due to the increase of orchard pests and diseases a decline in orcharding set in, and this was not checked until 1903, when the Orchard and Garden Diseases Act was intro-

duced. A revival then took place and exports recommenced in 1910, but stopped again during the Great War. A new start was made in 1920 on sound lines under Government supervision. Scientific discoveries in fruit carriage greatly assisted the industry.

"The area under apples now amounts to about 18,000 acres, the more important export districts being Nelson, Hawke's Bay, Auckland, Otago, Blenheim and Wairarapa. Yields vary from 250 to 1,000 cases per acre, and the export has amounted to 1,500,000 cases in one year.

"1. *A Fruit Orchard, New Zealand.*—Areas composed of low hills, easy slopes, river valleys and plains are selected for orchards. The sites of former Kauri forests known as 'gum' lands, from which Kauri gum is dug, are found suitable for apple-growing, although too poor for agricultural crops.

"2. *Spraying an Orchard for Pests.*—This is an important operation and is carried out in winter when the trees are bare of leaves. Portable spraying machines are used, but the large orchards are usually fitted with a stationary spraying system comprising a pumping station with high pressure pipes throughout the orchard. The spray liquid is forced through rubber hose pipes 90 ft. to 150 ft. in length at a pressure of from 300 to 350 lbs.

"3. *An Apple Orchard in Blossom.*—An apple orchard in spring when the trees are covered with the delicate pinkish white flowers presents a delightful picture.

(Note the fruit-grower's bungalow on the left and the 'wind-belt' of tall trees in the background planted to protect the trees from cold winds during the blossoming period.)

"4. *Picking Apples.*—This sturdy youth is engaged on the pleasant task of harvesting apples in the open air and warm sunshine. He is mounted on a tripod ladder so as not to injure the trees and he handles the fruit carefully, placing each apple in the loose holder suspended from his neck so that it arrives unbruised at the grading shed.

"Apple trees are almost entirely raised on the 'Northern Spy' stock which promotes early bearing and has a semi-dwarfing habit. The centre of the tree is kept open by pruning, causing the side branches to develop, thus enabling most of the fruit to be gathered without the aid of ladders.

"5. *Grading and Packing New Zealand Apples.*—Definite standards relating to the grading and packing of apples for export are maintained by the Department of Agriculture. These standards take into account maturity, colour, blemish, russet and other defects. Grading for size is done by passing the fruit over a mechanical grader or sizer. Fruit of one size and grade only is packed in one case, and each fruit is wrapped in tissue paper in the process of packing. The fruits are placed in the cases in what is termed the pocket or diagonal system, the fruit of each layer resting in the small 'pocket' or space between the fruits of the layer below and not one fruit directly upon another.

"The standard export case has an inside measurement of 10½ in. × 11½ in. × 18 in.

"6. *New Zealand Apples for Export.*—Fruit is transported by lorry to the local railway station or coastal wharf whence it is conveyed by rail or steamer to one or other of the main ports for loading on to overseas steamers. Cool chambers are provided on board in which the fruit remains in good condition during lengthy voyages.

"The principal market for New Zealand apples is the United Kingdom."

Imperial Institute Scheme for Empire Lectures to Schools.—In addition to its scientific and technical work on raw materials of the Empire, the Imperial Institute is becoming more and more widely known as a centre of visual instruction in the life, scenery, and industries of the overseas Empire.

Its latest activity is the organisation of lectures on Empire subjects by a panel of lecturers who have first-hand experience of the Dominions, of India or Burma or of the Colonies. The lectures will be given to primary and secondary schools of the United Kingdom outside the County of London and will be accompanied wherever possible by displays of films or lantern slides from the Empire Film Library and Empire lantern slide collections of the Institute. In schools where projectors or lanterns are not available the talks will be illustrated by maps, pictures or diagrams. It will naturally take some time before the scheme is in full working order. In the first instance education authorities in certain selected areas have been approached and their co-operation invited with a view to lecturers being sent to schools within their respective jurisdictions. At present the authorities in the following areas are participating in the scheme: Middlesex, Surrey, Warwickshire, Birmingham, Coventry, Leicester, Liverpool, and Manchester. Thirty-five lecturers have so far been appointed to the panel and numerous lectures have been arranged, the bookings in some cases being as far ahead as November.

It is hoped by this means to tell the story of the Empire to the rising generation and to bring home to them its meaning and its values as a world-wide community of peoples, some of whom are already fully self-governing nations, or are rapidly advancing towards equal partnership; while for the development of others not yet able to stand alone Britain accepts the responsibility of a trustee.

Colonial Visitors.—The following is a list of officers on leave from the Colonies, etc., who have visited the Institute during the three months February, March and April 1940.

FEBRUARY

Dr. D. R. GRANTHAM, Geologist, Lands and Mines Department, Tanganyika Territory.
G. T. PHILPOTT, Tobacco Officer, Department of Agriculture, Uganda.
J. B. G. SAVORY, Agricultural Officer, Nigeria.
G. H. VIVIAN, Inspector of Mines, Nigeria.
Dr. S. G. WILLIMOTT, Chemist, Straits Settlements.

MARCH

H. M. PENDLEBURY, Director of Museums, Federated Malay States.
Lt. C. J. TAYLOR, Assistant Conservator of Forests, Gold Coast.
R. TURNER, Agricultural Officer, Nigeria.

APRIL

J. S. P. BEARD, Assistant Conservator of Forests, Trinidad.
G. K. G. CAMPBELL, Botanist, Nigeria.
Dr. H. EVANS, Botanist, Department of Agriculture, Mauritius.
P. H. JENNINGS, Deputy Auditor, Colonial Audit Department, Gold Coast.
P. F. MASON, Assistant Conservator of Forests, Nigeria.
H. J. TAYLOR, Agricultural Superintendent, Nigeria.

All Dominion and Colonial Officers, as well as private residents overseas, who may be visiting London, are cordially invited to come to the Institute to see our Exhibition Galleries and to discuss scientific and technical problems in which they may be interested.

BULLETIN
OF THE IMPERIAL INSTITUTE

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PLANT AND ANIMAL PRODUCTS

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Indian and Colonial Governments

YOUNG TEAK FOR PAPER-MAKING FROM TRINIDAD

In connection with the teak plantations which have been established in Trinidad, it was desired to ascertain whether an outlet could be found for the young thinnings as a source of paper pulp. Material was therefore sent over by the Conservator of Forests in order that the necessary trials could be carried out at the Imperial Institute.

The sample consisted of bundles of billets of about 2 ft. in length, cut from trees four and three years old respectively. The former were marked A and the latter B. Both sets of material were similar in appearance, being free from bark, clean, straight and in good sound condition.

The wood was of a light buff colour, fairly hard, and of moderately high density. Through the centre of each billet ran a core of white pith of rectangular cross-section, surrounded by a narrow brown border with short brown lines radiating diagonally outwards from each corner.

In dimensions the material ranged from sticks of less than ½ in. in diameter up to pieces nearly 6 in. in diameter. As will be seen from the following measurements, Sample A, from 4-year-old trees, consisted of appreciably larger material than Sample B :

	Age of trees. *Years.*	Minimum diameter. *ins.*	Maximum diameter. *ins.*	Average diameter. *ins.*
A .	4	0·4	5·8	1·75
B .	3	0·4	4·0	1·5

Results of Examination

Chemical Examination.—Representative portions of the samples were finely ground and examined with the results given in the following table:

	A		*B*	
	Expressed on the wood as received. *Per cent.*	Expressed on the moisture-free wood. *Per cent.*	Expressed on the wood as received. *Per cent.*	Expressed on the moisture-free wood. *Per cent.*
Moisture . . .	8·1	—	9·1	—
Resins (material soluble in alcohol-benzene) . .	1·15	1·75	0·9	1·0
Alkali solubility .	11·0	12·0	9·4	10·3
Cellulose . . .	51·2	55·7	51·3	56·4
Ash . . .	0·8	0·9	0·9	1·0

It will be seen from the analytical figures given above that both samples of young teak contain similar, and satisfactorily high, percentages of cellulose. The resin content was in each case very low, being slightly higher in the case of the older wood (Sample A). In general the analyses do not reveal any significant differences in the composition of the two samples.

Microscopy of the Ultimate Fibres.—Ultimate fibres were prepared from the two samples of wood and were examined microscopically. Both samples were found to give ultimate fibres of very similar appearance, the fibres being short, thin-walled and possessing gradually tapering ends. Small cells were numerous and some finely-marked vessels were also present.

The dimensions of the fibres were measured by means of a projection microscope with the following results:

	A			*B*		
	Maximum. *mm.*	Minimum. *mm.*	Average. *mm.*	Maximum. *mm.*	Minimum. *mm.*	Average. *mm.*
Length .	1·5	0·4	0·9	1·6	0·4	1·0
Width .	0·044	0·014	0·027	0·044	0·014	0·025

It will be seen from the above figures that the two samples of teak were again almost identical in their fibre measurements, which class them as short-fibred materials from a paper-making point of view. Such materials can only give weak types of paper and are only capable of being used for filler purposes in the manufacture of printing and writing papers.

Paper-making Trials.—Owing to the poor fibre length of the present samples these woods would be most suitable for commercial treatment by the soda process, and accordingly in the paper-making trials which were carried out this process alone was employed.

The wood was first converted into chips by sawing into ¾-in. discs from the billets and reducing these sections to chips, which were thus of uniform length. The wood contained few knots and chipped up readily without yielding an excessive quantity of waste. The chips measured approximately ¾-in. long, ¾-in. wide and 3/16 in. thick.

The chips were then cooked in a rotary digester under conditions approximating to those employed commercially for the production of wood pulp by the soda process.

Details of the cooking conditions employed, the soda consumption and the yields of unbleached pulp obtained are given in the following table. The time to attain to the maximum temperature was standardised at 1 hour.

CONDITIONS OF DIGESTION

Digestion No.	Raw Material.	Maximum Temperature.	Time at Maximum Temperature.	Strength of Caustic Soda.	Caustic Soda per 100 parts of moisture-free wood.	Soda consumption on 100 parts of moisture-free wood.	Yield of moisture-free unbleached pulp on moisture-free wood.
				Per cent.	*Parts.*	*Parts.*	*Per cent.*
No20	A	160° C.	5 hrs.	4	24	12·0	51·5
No21	A	170° C.	5 hrs.	4	24	14·2	46·7
No22	B	170° C.	5 hrs.	4	24	14·6	46·2
No23	A and B in equal proportions	170° C.	5 hrs.	5	30	—	42·4
No24	A and B in equal proportions	170° C.	7½ hrs.	6	30	17·6	39·5
No25	A and B in equal proportions	175° C.	7½ hrs.	5	30	18·9	35·2

Sample A, when digested under the conditions of trial No20, gave a shivy, rather undercooked pulp. Accordingly, cook No21 was carried out under slightly more severe conditions, whereupon the yield amounted to 46·7 per cent. and the pulp obtained was thoroughly broken down and free from shive. The figure of 46·7 per cent. may, therefore, be taken as closely approximating to the maximum yield of unbleached pulp (expressed as percentage of moisture-free pulp on moisture-free wood) which can be obtained from the present Sample A of 4-year-old teak wood.

Digestion No22 was next carried out, in which Sample B was treated under precisely the same conditions as had been employed in No21 for the digestion of Sample A. The yield obtained, viz., 46·2 per cent., is, within the limits of the experimental error, identical with that obtained from Sample A when digested under the same conditions. It was evident, therefore, that in chemical composition, fibre length and pulping properties the 3-year-old and the 4-year-old teak were almost identical. For the purpose of further paper-making trials it was decided, therefore, to reduce the number of cooking trials by working on a mixture of equal proportions of A and B.

Bleaching Trials.—Digestions No23, No24 and No25 were all undertaken in an endeavour, by the use of more drastic cooking conditions, to carry delignification to a stage at which an easy-bleaching pulp could be produced. It will be noted that in cook No25 the yield of unbleached pulp had fallen to the low value of 35·2 per cent.

The bleachability of each pulp was evaluated by carrying out a series of small-scale tests in which a known weight of the pulp was

shaken at 5 per cent. consistency with various known concentrations of standard bleach solution and the degree of bleaching observed.

Despite the severity of the cooks in no case was pulp obtained which could be readily bleached.

It is possible that a 2-stage alkali digestion on the lines of the Raitt process as employed for bamboo or a multi-stage bleaching process would yield a pulp with desirable bleaching properties, but it is unlikely that either the amount of teak available in Trinidad or the value of the pulp would justify the expense of developing a special technique for its treatment.

Pulp Evaluation.—In order to evaluate the strength and general quality of the pulps obtained in the cooking trials, standard sheets were prepared by means of the British Standard Sheet Machine using the official method described in the Second Report of the Pulp Evaluation Committee of the Paper Makers' Association. The sheets were dried and conditioned overnight at 70° F. and 65 per cent. relative humidity prior to testing, which was carried out according to the Paper Makers' Association official methods. The results of the tests on the standard sheets are given in the following table:

Digestion.	No20.	No21.	No22.	No23.	No24.
Basic weight, in grams per sq. metre	62·7	61·5	61·0	62·1	61·0
Thickness, in microns	129	120	120	121	121
Bulk, in cc. per gram	2·1	2·0	2·0	1·9	2·0
Burst factor, in grams per sq. cm.	9·0	10·7	12·6	11·6	9·0
Breaking length in metres	2610	2670	2680	2600	1940
Stretch, per cent.	0·8	1·1	1·6	1·3	1·7
Remarks	Rather shivy. Brown colour. Well-formed sheets.	Clean. Brown colour. Well-formed sheets.	Clean. Brown colour. Well-formed sheets.	Clean. Pale brown. Well-formed sheets.	Clean. Pale greyish-brown. Well formed sheets.

It will be noted from the figures given in the above table that the more drastic cooking conditions employed in cook No24 have given an appreciably weaker pulp. The endeavour to produce an easy bleaching pulp by more severe digestion has thus not only reduced the yield of pulp but also noticeably reduced its strength.

Beating trials were not carried out in view of the short-fibred nature of the pulp, and the fact that a good bleached pulp was not obtained.

Remarks

The present investigation has shown that:

(*a*) Young teak wood is a short-fibred material which, from the point of view of paper-making, is similar to woods such as aspen (*Populus tremuloides*) which find little outlet in paper-making except in the form of bleached soda pulps.

(*b*) Both the 3-year-old and the 4-year-old wood are similar in chemical composition, fibre length and paper-making properties. The wood contains a high percentage of cellulose.

(*c*) Young teak wood is readily digested by the soda process but does not yield an easily bleachable pulp. Efforts to obtain a bleachable pulp by the employment of more drastic cooking conditions reduced the yield and the strength properties of the pulp without producing the desired effect.

Conclusions

It is not considered that young teak thinnings would be a promising raw material for paper-making owing to the short length of the ultimate fibres and the difficulty experienced in producing an easy-bleaching pulp.

HAL RESIN FROM CEYLON

HAL is the local name for *Vateria copallifera* (Retz) Alston (= *V. acuminata* Heyne), a large tree, endemic to Ceylon, where it is common in the moist low country, especially near streams, up to an altitude of about 2,000 ft. It belongs to the Dipterocarpaceae and is described as a very beautiful tree, often planted for ornament, with spreading branches, large oblong leaves and cream-coloured, sweet-scented flowers an inch in diameter. Like the related *Vateria indica* L. of India, from which piney resin (Indian copal or white damar) is derived, the stem exudes in abundance a clear yellowish resin, samples of which have recently been examined at the Imperial Institute. The first sample, received from the Director of Commerce and Industries in 1938, gave such promising results that it was suggested that a larger quantity of the resin should be supplied to enable the material to be submitted to the trade for technical trials. Four further samples were accordingly forwarded in April 1939. It was stated that under normal conditions it would be possible to supply 200 to 300 cwts. of the resin annually, and that the supply would be likely to increase in the event of there being an active demand for the material.

The detailed results of the investigation of the samples are given below.

I. Sample Received in 1938

This sample, which weighed 4 lb. 10 oz., consisted of a mixture of pieces of clean, translucent resin of pale lemon-yellow colour and pieces of reddish-brown resin, together with some conglomerate masses of the pale and darker resin, and also a little bark and other vegetable debris. The pale resin consisted of fairly large stalactitic tears, measuring up to 2½ in. × 2 in. × 1 in., and smaller pieces, whilst the reddish-brown material contained, besides stalactitic

tears, irregular masses measuring up to $4\frac{1}{2}$ in. × $3\frac{1}{2}$ in. × 2 in., together with smaller pieces. A small amount of fine dust was present in the sample. The resin, as received, was covered with a very slight white oxidised crust.

The resin was brittle and had a glassy fracture, but was not very hard.

Results of Examination

By hand-picking, the sample was separated at the Imperial Institute into two main portions, consisting respectively of (A) the pale lemon-yellow resin and (B) the reddish-brown material, together with the conglomerate masses of pale and darker resin; and a third portion (C) composed of small fragments and dust passing through a 0·5 cm. sieve. The amounts of these portions, as percentages of the entire sample, were as follows:

		Per cent.
A.	Pale lemon-yellow portion . . .	48
B.	Reddish-brown and mixed portion . .	47
C.	Small fragments and dust . . .	5

Representative samples of the two portions A and B were ground and examined, with the following results:

		Portion A.	Portion B.
Moisture, etc. (loss at 105° C.) . .	*per cent.*	0·7	1·9
Dirt (matter insoluble in chloroform) .	,,	0·25	4·4
Ash	,,	0·03	0·13
Acid value		12·8	18·8
Saponification value		19·3	*24·0

* *Determined on the material soluble in benzene, which amounted to 90 per cent. of the portion.*

Portion A was further examined as follows:

Solubility.—The resin was completely soluble in chloroform; almost completely soluble in benzene; somewhat less soluble in turpentine oil, linseed oil, and a mixture containing 33 per cent. ethyl alcohol and 67 per cent. benzene; and almost insoluble in acetone, ethyl alcohol, amyl alcohol, ether, and light petroleum.

Melting Point.—Employing the capillary tube method, the resin softened at about 84° C. and swelled up or sintered at about 118° C., at which temperature it was fairly fluid.

Varnish Trials.—A varnish was made up with equal weights of resin and oil of turpentine and filtered whilst warm. On cooling and applying to sized wood, the varnish dried in about 48 hours, furnishing a pale, glossy, fairly tough coat.

Commercial Value

Consideration was given to the commercial value of the resin at a meeting of the Imperial Institute Consultative Committee on

Gums and Resins, when the two portions A and B of the present sample were exhibited and the members were informed of the results of the foregoing examination.

The Committee considered the resin to have the appearance and properties of a damar. So far as could be judged from the results of examination and from the materials placed before them, they considered that the original unsorted resin might realise a price in the neighbourhood of 50s. per cwt. in London, being on a par with damar "sorts" (January, 1939).[1] The pale resin alone should be worth more, but the darker material would be classed as dark or "stone" damar, and reduce the value of the product as a whole.

The Committee, however, expressed the view that before a reliable opinion on the value of the resin could be formed it would be necessary for larger quantities to be forwarded from Ceylon for technical trials, although the expense involved in such trials would only be warranted provided adequate supplies of the resin were obtainable.

Remarks

The foregoing examination has shown, as already mentioned, that the material has the general characteristics of a damar resin, being brittle and readily crushed, and harder than rosin, but not so hard as the copal resins. Moreover, the product showed good solubility in oil of turpentine without a previous "running" of the resin, but, unlike some species of damar, it was not soluble to any extent in alcohol.

As regards its chemical constants, the sample gave a satisfactorily low acid value, lower than that recorded for most varieties of commercial damar resins. The pale resin present in the sample (Portion A) compared favourably with the best grades of commercial damar, and the fact that it could be separated fairly readily by hand from the darker material would suggest that, if available in commercial quantities, it would probably pay to grade the resin in Ceylon. The pale resin only, which should command a good price, could then be exported, the dark-coloured lower-grade material being employed for local use unless it is available in very large quantities and the price eventually obtainable in the United Kingdom proves sufficiently attractive to warrant its export. In this connection it may be pointed out that during recent years, owing to the keen competition of synthetic resins, colour in natural resins has become an even more important factor than before in determining their market value. It is owing to their very pale colour and their fairly ready solubility in oil of turpentine or alcohol that damar resins find a ready market and are employed largely in the manufacture of the so-called spirit varnishes used for interior decoration,

[1] As will be seen from the report on the later samples (p. 292), this preliminary valuation was rather high.

wall-papers, and various fabrics where colour is a most important consideration. Moreover, on account of their pale colour, they have also found extensive applications during recent years in the production of pyroxylin lacquers and enamels.

II. Samples Received in 1939

These samples were labelled A, 1, 2, 3, and weighed 84 lb., 144 lb., 94 lb. and 28 lb. respectively. The material was similar in appearance to the sample previously received but had been separated into different grades which varied from sample A, consisting of fairly clean almost transparent resin, pale yellow to pale amber in colour, to sample 3, which was opaque and very dark in colour.

Samples 2 and 3 both contained an appreciable amount of adherent bark and other vegetable debris. The pieces of resin in these samples were mainly stalactitic in form, and many of them were considerably larger than those received previously, measuring up to 7 in. × 3½ in. × 3 in. in sample 1.

Results of Examination

Representative portions of each sample were finely ground and submitted to examination. The results are given in the following table.

	A.	1.	2.	3.
Moisture, etc. (loss at 105° C.) *per cent.*	1·4	1·5	3·2	1·7
Dirt (matter insoluble in chloroform) *per cent.**	1·7	1·0	9·6	9·6
Matter insoluble in oil of turpentine, *per cent.*	12·2	15·7	24·7	24·2
Ash . . . . *per cent.*	0·37	0·31	3·81	4·73
Softening point, ° C. . . .	88	106	115	81
Melting point, ° C.	107	126	130	101
Acid value	17·4	22·7	27·8	25·8
Saponification value . . .	36·2	53·7	68·5	61·8

* *The samples were, apart from dirt, almost completely soluble in benzene and toluene.*

The results of the examination show that the general properties of the present four samples of Hal resin are similar to those of the previous sample. It will be seen that, allowing for the amount of dirt present, as indicated by the portion insoluble in chloroform, the paler-coloured resin represented by sample A was rather more soluble in oil of turpentine, and furnished lower acid and saponification values than the other samples, Nos. 1, 2 and 3.

Commercial Valuation

The bulk of the four samples was submitted to two firms of resin merchants and varnish manufacturers represented on the Imperial Institute Consultative Committee on Gums and Resins in order that technical trials might be carried out with a view to determining the market possibilities of the material.

The member representing one firm reported as follows (June 1940):

"The 'A' grade I should estimate as worth about 45s. per cwt. c.i.f. London, and coming from a British Colony it would not be subject to the 10 per cent. duty on gum damar. It is, however, very badly graded, and if it could be sorted into three grades such as Best, Medium and Pickings, it would be easier to handle. I am sending you small samples of what I mean by Best and Pickings, to show how it should be sorted.

"The No. 1 grade we have not bought since the war started, and we were paying 25s. per cwt. for this. At the present time I should estimate the value at about 30s. per cwt., perhaps a little more.

"No. 2 Grade contains a lot of bad pickings which would spoil the sale of this article. If these pickings were removed it would be worth about 25s. per cwt. I am sending you a sample of the pickings from No. 2 grade, to show you what I mean.

"No. 3 is not worth shipping over here although it contains a small proportion of gum which could very well be put into No. 2."

The representative of the other firm stated that he had previously obtained samples of this resin from Ceylon, and that its properties come between those of a damar and a copal. Owing to its poorer solubility in oil of turpentine the resin was inferior to commercial damar resins, but he considered that it might form a soluble product after "running." In view, however, of its inferior hardness as compared with copals he doubted whether it would bear the expense of "running." The four samples were submitted by him to a well-known firm of varnish makers, who furnished the following report:

"We have examined the four samples of Hal resin, and the results of our tests are as given below:

	A.	1.	2.	3.
Solubility in methylated spirit	Insoluble	Insoluble	Insoluble	Insoluble
Solubility in white spirit (light petroleum)	Partially soluble	Partially soluble	Partially soluble	Partially soluble
Solubility in toluene	Soluble	Soluble	Soluble	Soluble
Acid value	13·8	19·6	24·4	15·2

"The four samples seem to be different grades of the same type of resin graded according to colour, No. A being the palest.

"They are all recent soft resins which could be used to some extent to replace damar in cellulose lacquer.

"Hal resin could probably be used in oil varnishes as we have found that the operation of running, oiling up and thinning proceeded normally.

"Although these are soft resins we have found a tendency to come out of solution unless they are run at a sufficiently high temperature."

Remarks

The results of the present examination confirm those obtained for the material dealt with in the earlier report, and show that this resin has properties resembling those of a damar resin although of inferior solubility. It would seem clear from the trade reports that if properly graded the material would have no difficulty in finding a market in this country. It was pointed out to the Ceylon authorities that it would be desirable to pay special attention to the graded samples submitted by one of the firms consulted, as the successful marketing of the product will depend to no small extent on satisfactory grading. A purchaser of a specified grade of resin should always be able to rely upon obtaining a product of the same standard quality as regards colour, size and purity.

JAK TREE RESIN FROM CEYLON

The results of an examination of a sample of the dried latex of the jak tree (*Artocarpus integer*) was published in this BULLETIN, 1938, **36**, 162. It was suggested in that report that a larger quantity of the material should be forwarded so that it could be subjected to fuller investigation and submitted to the trade. A further sample was subsequently forwarded to the Imperial Institute by the Trade Commissioner for Ceylon, and is the subject of the following report.

The sample, which weighed 11 lb., consisted of three roughly-rectangular blocks of dark reddish-brown, opaque, soft, sticky resinous material, similar in appearance and general properties to the previous sample.

Results of Examination

A representative portion of the material was extracted successively in a Soxhlet extractor as in the case of the previous sample, first with acetone, then with benzene and lastly with chloroform. The results obtained, together with the amount of ash furnished by the material, are shown in the following table in comparison with the figures obtained for the previous sample:

	Present Sample. *Per cent.*	Previous Sample. *Per cent.*
Material soluble in acetone	93·9	90·8
Residual material soluble in benzene	2·9	2·1
Residual material from benzene extraction soluble in chloroform	0·1	0·3
Matter insoluble in acetone, benzene and chloroform	1·8	6·6
Moisture, etc. (by difference)	1·3	0·2
Ash	0·5	2·4

It will be observed that the present sample was more free from vegetable and mineral impurities (as shown by the smaller amounts insoluble in acetone, benzene and chloroform, and the lower ash)

and that it contained rather more moisture than the previous sample. After making allowance for these differences the proportion of material soluble in acetone was about the same, that of the residual material soluble in benzene somewhat higher, and the proportion of residual material soluble in chloroform lower than was the case with the previous sample.

Residual Material soluble in Benzene.—This differed from the corresponding material isolated from the previous sample of Jak tree resin. It consisted of a pale yellow, elastic solid resembling caoutchouc, the odour on burning being similar to that of burning rubber. After vulcanisation with sulphur the resulting product was very weak. It would thus appear that the present sample contained 2·9 per cent. of the "caoutchouc-like substance" reported by some observers (up to 7·7 per cent. has been recorded) whereas the previous sample contained none, in this respect agreeing with other authorities who have examined Jak tree latex. Examination of the two samples at the Imperial Institute thus indicates that the composition of the latex is subject to some variation.

Acetone-soluble Material.—The acetone-soluble material had the following constants which are shown in comparison with those of the material obtained from the previous sample:

	Present Sample.	Previous Sample.
Acid value	5·6	6·5
Saponification value	39·2	41·9
Softening point*	Indefinite, about 40° C.	Not observed
Melting point*	61° C.	60° C.

* *Capillary tube method.*

It is apparent that the constants of the two samples are very similar. Like the previous sample the present material consisted of a moderately hard, translucent, yellowish-brown resin.

Solubility of Acetone-soluble Material.—One-gram portions treated with a number of organic solvents behaved similarly to the previous sample, that is, the resin was completely soluble in hot acetone, benzene and chloroform, and almost entirely soluble in hot alcohol, ether and turpentine oil, but appeared to be only slightly soluble in hot petroleum ether. Again, as with the previous sample, after cooling the solutions and allowing them to stand overnight, the resin remained completely in solution in the chloroform and almost completely so in the benzene, whilst the solutions in acetone, alcohol, ether and turpentine oil had deposited greater or less amounts of a white, amorphous powder, the largest amount being deposited from the alcoholic solution.

White Deposit from Solutions.—The white amorphous material was separated as completely as possible from a larger quantity of the acetone-soluble resin by crystallisation from acetone, the amount so obtained being approximately 21 per cent. of the acetone-soluble resin. On further examination, with repeated recrystallisation

from acetone, this white material separated into two distinct substances, possessing different solubilities in acetone, as follows:

A.—The less soluble, consisting of a dense white amorphous powder.

B.—The more soluble, consisting of white glistening flakes.

The relative proportions by weight of A and B were approximately 1 : 3.

These two substances had the following constants:

	Substance A.	Substance B.
Acid value	1·4	0·3
Saponification value . .	81·1	3·1
Melting point* . . .	76-77° C.	108° C.

* *Capillary tube method.*

Substance A was evidently a resin ester, whilst Substance B, which was probably contaminated with a little of A, was a neutral body, probably an alcohol from its stability towards boiling alcoholic potash, though sufficient of the material for further examination was not obtained.

Acetone-Soluble Resin, freed (as far as possible) from Substances A and B.—Although the acetone-soluble resin obtained from the original material appeared to be only slightly soluble in petroleum ether, when tested in the manner described, it was found that considerable amounts of the material were, in fact, soluble in this solvent. The resin, after the separation of the substances A and B described above, was therefore exhaustively extracted with petroleum ether. On removing the solvent from the extract a pale amber-coloured, very soft resin remained, amounting to about 54·5 per cent. of the original acetone-soluble material. The resin insoluble in petroleum ether was dark reddish-brown in colour, hard and brittle, and amounted to about 24·5 per cent. of the acetone-soluble material.

These two resins had the following constants:

	Resin soluble in petroleum ether.	Resin insoluble in petroleum ether.
Acid value	4·2	15·5
Saponification value . . .	35·1	76·5
Softening point*	About 22° C.	88-90° C.
Melting point*	About 38° C.	100-101° C.

* *Capillary tube method.*

Although when first obtained the resin soluble in petroleum ether was quite clear and transparent, after keeping for some weeks the outer surface became dull. The resin also hardened somewhat on keeping.

Varnish Trials.—Alcoholic solutions of the above two resins behaved as follows when applied to sized wood:

The solution prepared from the resin soluble in petroleum ether dried fairly rapidly, furnishing a pale, glossy, but very soft coat.

After some weeks the surface became opalescent and the coat much harder.

The insoluble resin solution furnished a dark reddish-brown, hard, glossy coat, which however very soon developed numerous cracks.

Summary

The present sample of Jak tree resin from Ceylon has been examined somewhat more fully than the previous sample, and has been separated into the following fractions:

	Fraction.	Approximate amount. *Per cent.*
Soluble in acetone	Dense white amorphous powder, A, melting point 76-77° C.	4·9
	White glistening flakes, B, melting point 108° C. . .	14·8
	Soft, pale-coloured resin, soluble in petroleum ether, melting point about 38° C.	51·2
	Hard, dark-coloured resin, insoluble in petroleum ether, melting point 100-101° C.	23·0
Caoutchouc-like material, insoluble in acetone, soluble in benzene .		2·9
Residual material soluble in chloroform, dirt, moisture, etc. . .		3·2

Commercial Value

The present material was submitted to the Imperial Institute Consultative Committee on Gums and Resins, who were also furnished with the results of the investigation carried out at the Imperial Institute. One of the members considered there might be some possibility of its commercial utilisation, and this member's firm was subsequently supplied with a sample of the material and also with fractions isolated at the Imperial Institute from it. This firm's examination of the samples had strengthened the opinion that Jak tree resin might prove to be of value, but before arriving at a definite conclusion they would require a larger amount for more extensive trials. The request of this firm to be supplied with a larger quantity of the resin has been duly submitted to Ceylon.

ACACIA LAETA GUM FROM NIGERIA

THE sample of gum arabic which is the subject of this report was forwarded to the Imperial Institute by the Assistant Conservator of Forests in charge of Bornu Forest Circle, in April 1939.

The material was stated to represent the gum of *Acacia laeta* R. Br. growing in Bornu Province, and it was desired to ascertain its commercial possibilities. *A. laeta* is a small tree occurring also in north-east and east tropical Africa, including the Sudan, Abyssinia, Tanganyika and Kenya.

The sample, which weighed 2½ lb., consisted of tears measuring up to 1¼ in. in the longest axis, broken fragments and a little coarse powder. Most of the tears were clear, but some had a weathered,

opaque outer layer. A few tears were light amber in colour, but most, particularly the larger pieces, were pink to reddish. There was very little impurity in the sample except for a few fragments of woody tissue embedded in the tears.

Results of Examination

A portion of the sample was ground and examined with the following results to which are added for comparison the corresponding figures for a sample of *Acacia verek* gum from Bornu Province previously examined at the Imperial Institute (this BULLETIN, 1934, **32**, 349).

		Acacia laeta.	*Acacia verek.*
Moisture	*per cent.*	13·4	15·7
Ash	„	2·9	3·4
Acid value		2·1	3·6
Matter insoluble in cold water	*per cent.*	0·5	0·3
Viscosity of a 10 per cent. solution at 20° C. compared with water at 20° C.		(The gum formed a jelly)	16·6
Viscosity of a 5 per cent. solution at 20° C. compared with water at 20° C.		10·7	—
Colour of a 10 per cent. solution in water		Light yellowish-brown	Almost colourless

Commercial Value

The gum was submitted to (*a*) merchants and (*b*) confectionery manufacturers in the United Kingdom, who offered the following observations respectively (September 1939):

(*a*) " We have completed our test of the sample submitted and beg to report as follows:

" The test was made on the usual commercial basis of 3 oz. gum to 1 gill of water.

" Solution extremely pale and slightly opaque, very strong, high viscosity and very ropey.

" This type of gum found favour prior to the re-conquest of the Sudan, but subsequently gradually fell into disuse as supplies of Sudan gum increased. The advantage of Sudan gum over the type represented by your sample is that it can be used for all purposes, whereas the other quality is suitable for the confectionery trade only. We estimate the value of the sample at approximately £33 per ton net, c.i.f. London."

(*b*) " This sample consisted of small tears and broken fragments of a pale colour. It has been well cleaned and contains no bark or fibre, and in appearance conforms to the standard for a good quality Nigerian gum arabic.

" The following tests were made on a solution containing 25 grams of the gum in 50 ccs. distilled water:

Acidity—3·6 ccs. N/1 NaOH per 100 gms. of gum.

Colour—4·7° Lovibond.

Taste—Bland; practically tasteless.

"The solution contained a large amount of jelly. Most gums of high jelly content give a homogeneous solution which is difficult to pour, but this sample yields a solution containing firm clots of jelly from which gum solution can be poured off.

"This is a gum of good quality. It is quite likely that it has been used in sweet making in admixture with Nigerian *Acacia verek*, but whether it could be used alone cannot be stated without trial. The large amount of jelly it contains would render it difficult to handle as an adhesive unless the user had some means of destroying the jelly.

"The market value of the gum would be about 3*s*. per cwt. less than Kordofan gum, say 38*s*. at present."

Remarks

The results of examination show that the present sample of *Acacia laeta* gum, although pale in colour and of attractive appearance, was inferior in quality to *A. senegal* (= *A. verek*) gum, as it was not so soluble and formed gelatinous mucilages with comparatively weak solutions. For this reason the commercial applications of the gum compared with those of good samples of *A. senegal* would be more restricted and its market price accordingly lower. As suggested by the two firms consulted, the gum would be utilised chiefly by the confectionery trade.

ARTICLE

CHICLE, JELUTONG AND ALLIED MATERIALS

At the last meeting of the Imperial Institute Consultative Committee on Gums and Resins it was suggested that the available information on the various forms of latex employed in the manufacture of chewing gum should be collected together and published in this BULLETIN. *This recommendation was adopted, and the following article dealing in the main with the two most important bases of chewing gum, viz., chicle and jelutong, with notes on other similar products, has accordingly been compiled by Mr. E. H. G. Smith, of the Plant and Animal Products Department of the Imperial Institute. Advantage has been taken of the presence in this country of Mr. J. C. K. Marshall, of the Malayan Forest Service, to discuss various aspects of the question, and the Imperial Institute is greatly indebted to him for much useful information, especially in regard to jelutong, of which Mr. Marshall has had much first-hand experience.*

CHICLE is of economic importance on account of its use in the manufacture of chewing gum, which commodity may be regarded as a mixture of sugar and flavouring materials incorporated in what

is known as the " gum-base." At one time this essential ingredient of any chewing gum was provided almost entirely by chicle, but nowadays the gum-base consists more usually of a mixture of chicle and other materials with similar properties. These materials, of which jelutong is the most important, are normally available at a cheaper price than chicle.

Barron [21] has described the essentials of any chewing gum base as " that it should be tasteless, odourless, non-tacky thermoplastic and very slightly elastic. It should be ductile when soft, and must not deteriorate or grow mouldy in storage. It must obviously be harmless."

Of the raw materials concerned in the production of chewing gum base, chicle and certain other suitable gums are derived from Central and South America, including British Honduras, while jelutong and the various guttas are produced in Malaya and the East Indies, and red Kano gum in Nigeria. Empire countries thus play an important part in both the production and trade in these materials.

Chewing gum is largely manufactured in the United States, which is the chief centre of consumption of the commodity. It has been marketed in that country for at least some seventy years; chicle from Mexico was first employed in its manufacture about the year 1885, whereas the use of jelutong for this purpose is comparatively recent. It is also popular in the United Kingdom, and is produced here on a considerable scale by well-known manufacturers.

It is not possible to state precisely the quantities of the different materials used in this country, as chicle and the other ingredients of gum-bases are not shown separately in the official trade returns. The bulk of such imports have been shown for the years 1937 and 1938 as " chewing gum base," though it is possible that some small quantity of material used for this purpose may be imported under another heading, e.g., as gutta percha.

United Kingdom—Imports of Chewing Gum Base

(*In lb.*)

From	1937.	1938.
British Honduras	246,512	327,040
United States	917,056	1,007,552
Other countries	12,544	69,216
Total (*lb.*)	1,176,112	1,403,808
Value (*£*)	74,648	102,070

The portion of the above imports derived from British Honduras may be taken, it seems, as consisting of chicle, or of chicle and closely allied gums classified commercially as chicle. Similarly, imports from the United States may be regarded as being the quantities of proprietary chewing gum bases sent to the United Kingdom; these are in volume roughly three times the imports of chicle. It has long been recognised that manufacturers in this

country largely use imported gum-bases. Much jelutong undoubtedly comes in as an important ingredient of such prepared bases, though little of this material appears to reach this country direct and unmixed from producing countries.

Compared with the United States imports (see pp. 305, 315) the above figures illustrate how much smaller is the chewing gum industry in the United Kingdom. Incidentally, re-exports of gum-base materials from this country are relatively unimportant, most of the quantity imported being employed here.

Chicle

Chicle, or chicle gum, is the coagulated latex of the sapodilla tree, *Achras zapote* L. The sapodilla is well-known in tropical countries as it is often grown for its fruit; commercial supplies of chicle are, however, derived from trees growing wild in forest areas.

The sapodilla is indigenous to Central America, and the important producing regions lie roughly between the 23rd and 17th parallels of north latitude, though the distribution of the tree extends further south of this area [1, 2 and 3]. The tree is said to grow best on the calcareous soils of the Yucatán peninsula, which includes the northern half of British Honduras, the province of Petén in Guatemala, and the Mexican states of Quintana Roo, Campeche and Yucatán. To the west of the peninsula production occurs in a number of other Mexican states, including Chiapas, Tobasco, Vera Cruz, Oaxaca, Michoacán and Colima.

In Mexico, the sapodilla occurs most plentifully within the forests of the coastal regions bordering the Gulf of Mexico and the Pacific Ocean, and in the main on land below an altitude of about 3,300 ft. It is also found in other regions provided that these are sufficiently protected and that the winter temperatures are not too extreme.

In the extensive forests of this vast territory it has been estimated that there are at least a hundred million sapodilla trees, and in British Honduras alone there are some 2,000 sq. miles of sapodilla forest [4]. Within these forests tappable sapodilla trees are widely dispersed; usually these are only found in the density of one, two or perhaps three per acre, though in the best sapodilla forest rather more may occur. In consequence of this distribution the feature of the chicle producing industry is the itinerant collector, or "chiclero" as he is called, who wanders through the forest in search of trees fit for tapping.

Botany of Chicle

According to Record [3] three species of the genus *Achras* are found in the region extending from southern Mexico to northern Colombia. Of these the southernmost, *A. calcicola* Pittier, which may attain a height of 80 ft. and a diameter of 3 ft., is common in

Panama and Colombia; although the bark contains a copious white latex this species does not appear to be exploited for gum. A larger tree is *A. chicle* Pittier, from which the commodity crown gum is obtained; this is an appreciably taller species and may attain a height of 125 ft. The third member of the genus is *A. zapote* (syn. *A. sapota* L., and *Sapota achras* Mill.), the source of true chicle.

Popenoe [5] describes the sapodilla as sometimes attaining a height of 50 ft. to 75 ft., with a dense rounded or conical crown; the timber is hard and durable. Pittier [1] gives the height as reaching 65 ft. or more when fully grown. The flowers are white, and the fruit is a berry, variable in form and some 2 in. to 3 in. in diameter.

Pittier has recorded a number of popular names. It appears that in Mexico the tree may be known as zapote, zapote chico, or chico, in Guatemala as chicozapote, and in British Honduras as sapodilly [6]. A Spanish name in general use is níspero, and an English name is naseberry.

As would be anticipated with a tree producing a valuable economic product such as chicle, a number of forms or varieties of the sapodilla have been recognised in the forests.

Hummel [7] has described the following four forms from British Honduras:

(1) *Female sapodilla.* This tree produces the best chicle, and also has large edible fruit of good quality. The leaves of mature trees are smaller and closer together than those of other sapodillas.

(2) *Crown sapodilla.* Produces the second-best chicle. Very similar in appearance to the first-named form except that the fruit is different.

(3) *Male or bastard sapodilla.* Produces little chicle, which is of inferior quality. The leaves are larger and further apart than those of forms 1 and 2. The small inedible fruit is produced in small clusters. The tree does not fruit every year.

(4) *Chicle bull.* The most useless of the sapodillas, having leaves smaller than those of form 3. It is usually recognised by the fruits which grow like bunches of grapes.

In the above classification the terms "female" and "male" are colloquially used to denote superior and inferior plants and they have no botanical significance.

Lundell [6] mentions three varieties occurring in the Yucatán peninsula, zapote blanco, with a white latex and a high yield of gum, zapote colorado with a red latex, and zapote morado, which is similar except that the latex is a darker red in colour.

Collection and Preparation of Chicle

The procedure in chicle collection is in some respects similar to that of the Brazil nut industry, and in each case wandering labourers are employed to collect produce over large areas of forest. The

collection and preparation of the material has been described by Heyder [4] and other writers [8 and 9] and is well known.

Much of the sapodilla forest in the countries of production is controlled by large companies, but whatever the ownership of harvesting rights in the sapodilla forests, the tapping of chicle is normally deputed to contractors who each work an area of forest, and who in turn employ labourers to collect chicle; the latter are usually paid according to the quantity of produce obtained. Control of chicle collection has always presented a problem, as it is out of the question for any authority to maintain a proper supervision over the areas of forest involved. Thus much permanent harm is done by careless tapping and many trees are killed each year. For instance, in British Honduras there has been a nominal rule that trees below 1 ft. in diameter at breast height should not be tapped, but this rule has not been strictly adhered to.

Heyder describes the size of tree giving the best yield as about 18 in. in diameter and 30 ft. high to the first branch; such a tree would probably be some 50 years old. At a first tapping a mature tree may yield 4 lb. to 5 lb. of latex, at a second tapping about 2 lb., and at a subsequent tapping rather less. However, the sapodilla forests of British Honduras have been so heavily worked that such yields are in general no longer obtainable, and the same is said to apply to the more accessible forest areas elsewhere in Central America.

Chicle tapping occurs during the rainy season, in British Honduras from about October to March, though in Petén it may commence earlier. The tapper (chiclero) carries a cutlass, a climbing rope, and a supply of canvas bags to collect the latex. The bags are treated with rubber obtained from *Castilla elastica* trees which grow wild in the forest. Some chicleros employ climbing irons, but the use of these is not regarded entirely with favour as wounds caused in the trunks by their use are considered to affect adversely the flow of latex at subsequent tappings.

Tapping commences early in the morning, and work is usually finished by midday; the latex flows best during the early morning. Having selected a suitable tree from which the latex is likely to flow satisfactorily, which is ascertained by making a preliminary cut in the bark, a collecting bag is fixed to the base of the trunk. The chiclero then begins to make a series of zig-zag cuts in the bark about 18 in. apart which are continued up the stem as the tapper climbs. The cuts commence at a point about 2 ft. from the base of the trunk where the collecting bag is attached. According to Heyder, the zig-zag pattern of the cuts is employed as it can be made conveniently with the native "machete" (cutlass) which the workers carry, and the distance of 18 in. between cuts is that which long experience has proved to give the best flow of latex. If the cuts are made to extend more than about two-thirds of the way round the stem, or if these are made too deeply, which is

reported to be a common fault, the cambium will probably be killed. In this case the bark loosens and the tree dies slowly. Heyder reports that many mature trees have been ruined in the British Honduras sapodilla forests by such tapping, and it appears to be a general fault of chicle exploitation in all countries.

The time of second and subsequent tappings varies. Heyder states that a second tapping may be made after about three years on the area of the trunk left uncut on the first occasion, provided that the tree is in good health, but that for a tapping between the original cuts an interval of at least eight years must elapse. A Guatemalan authority suggests that trees may be retapped after six or seven years. The reduced yields obtainable from retappings are mostly accounted for by the interference to the bark vessels at the former tapping wounds.

In the collection of chicle the chicleros work in small parties. These establish temporary camps in the forest which are moved as each area is worked over. From the camps the workers go out singly, and each man may tap some half-dozen trees in a morning. When tapping is completed, the chiclero collects the bags of latex, emptying these into kerosene tins. The latex is taken to the camp, and when sufficient is available is boiled in an open cauldron with a capacity of some 40 gallons to reduce the water content. During boiling the latex must be kept constantly stirred, and when the material has been concentrated to the point at which it will set on cooling it is removed from the cauldron. The chicle is then placed on a piece of canvas, which has been rubbed with soap to prevent sticking, and kneaded into blocks which may weigh from 5 lb. to 25 lb., though blocks of about 20 lb. to 25 lb. seem to be most commonly produced. The blocks are left to dry for two or three days and then packed for export in bales or sacks which normally contain about 100 lb. of chicle.

In Petén it is reported that the chicle is made into blocks weighing about 25 lb. and that four of these blocks are packed together.

The chicle is sold by weight and also on the moisture content of the material which is tested by buyers. According to one authority American purchasers require that the blocks of chicle shall not contain more than about 30 per cent. of moisture. The blocks are also tested for adulteration ; the mixing of inferior gums with chicle can, it seems, be readily detected, while the practice of including extraneous make-weights, such as stones or pieces of bark, is not unknown. It appears that in Petén a small proportion of second grade material from the "chiquibul" tree may be mixed with the true chicle, though this gum is reported to be easily distinguishable from chicle and not normally accepted in foreign markets in the pure state. It seems extremely doubtful whether the chiquibul of Guatemala is the same as the chicle bull described by Hummel.

Chicle Production

Commercial supplies of chicle are almost exclusively derived from Mexico, Guatemala and British Honduras, in that order of importance. With the exception of relatively small exports of chicle from British Honduras to the United Kingdom and to Canada, practically the whole output is shipped to the United States, and the following statistics of imports of the material to the United States during the period 1935-39 provides the most useful indication of the present position of the industry.

IMPORTS OF CRUDE CHICLE TO THE UNITED STATES

From	1935. lb.	1936. lb.	1937. lb.	1938. lb.	1939. lb.
British Honduras	927,865	936,478	1,418,633	1,322,450	1,701,645
Mexico . .	6,339,508	5,180,193	7,958,813	4,922,912	10,925,539
Guatemala . .	507,848	626,365	1,275,851	1,623,466	2,051,220
Costa Rica . .	—	1,264	1,395	2,985	537
Other Countries* .	—	5,291	5,314	21	237
Total (*lb.*)	7,775,221	6,749,591	10,660,006	7,871,834	14,679,178
Value ($)	1,887,171	1,604,848	3,009,441	2,456,969	5,151,455

* *Mainly Venezuelan chicle ; this according to Vander Laan* [8] *is probably obtained from a species of Mimusops.*

British Honduras occupies a prominent position in the chicle trade, though the quantities now handled are not as large as these were formerly. Belize has an important re-export trade of Mexican and also probably of some Guatemalan chicle. Judging from statistical information re-exports have fallen off more heavily than domestic production. However, it has been suggested that approaching 20 per cent. of the British Honduras domestic export is provided by material smuggled from the Guatemalan province of Petén. It certainly seems probable that some Petén chicle passes through the colony though recorded re-exports of the material are given as of Mexican origin.

Recent statistical information for this dependency for the same period is as follows :

BRITISH HONDURAS

Domestic Exports of Chicle

To	1935. lb.	1936. lb.	1937. lb.	1938. lb.	1939. lb.
United Kingdom .	—	100,768	161,598	151,196	40,937
Canada . . .	159,381	124,651	42,743	255,782	90,881
United States . .	575,409	535,389	455,575	473,477	685,310
Germany . .	—	6,320	—	—	—
Total (*lb.*)	734,790	767,128	659,916	880,455	817,128
Value ($)	174,874	191,040	189,186	289,591	280,552
Imports of Chicle					
From Mexico . .	742,141	502,287	1,015,599	889,965	1,295,171
Re-exports of Chicle					
To United States .	577,538	767,231	1,035,078	903,015	1,165,585

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World production of chicle first reached a peak about 1913, when a total of some 9½ million pounds was attained. During the next decade, production as measured by the United States imports of the material averaged round about 8 million pounds per annum. Over the period 1924 to 1931 production increased to some 12 or 13 million pounds per annum, with 1930 the peak year during which nearly 14 million pounds of chicle were imported into the United States. As a result of the general trade depression annual average production during the next three years was only some 5 million pounds, the lowest production point being reached in 1933. Thereafter, a recovery in the trade took place, which was marked by the United States imports exceeding 10 million pounds in 1937. Thus the 1939 United States imports, approximately 14½ million pounds, may be taken as representing the highest total annual production so far recorded.

It is of interest to note that in 1939, and possibly to some extent due to the war, an appreciably smaller proportion than normal of the British Honduras domestic production was taken by the United Kingdom and Canada, while exports to the United States from this dependency were increased.

Judging from the evidence available from the trade returns the larger world crop of 1939, nearly double that of the previous year, caused no considerable fall in the value of the product, the two crops being valued for trade purposes at approximately the same rates per lb.

JELUTONG

Jelutong, or pontianak as it is sometimes called, is also a forest product, and is the coagulated latex of trees belonging to the genus *Dyera*, which occur in Malaya, Sarawak, the Netherlands East Indies and adjacent territories.

The material has long been known to commerce and was formerly exploited as an inferior variety of rubber, though as the coagulum consists mainly of resin it could not compete successfully with rubber. In 1922 jelutong suddenly found an outlet in the production of chewing gum base, in which application it is understood to be employed in admixture with other materials. According to Watson [10] it has been mixed with other substances to produce a base known to the trade as "paloja," while from another account it appears that it may sometimes be mixed with gutta hangkang and gutta ketiau for this purpose [11].

However employed, jelutong has been imported by the United States, where the material is almost exclusively marketed, in large quantities, total imports in recent years, with the exception of 1939, having been on the average approaching double those of chicle. The product represents a very important raw material in the production of chewing gum bases, though precise details of the actual

mixtures used in such bases are the commercial secrets of the manufacturers concerned.

The Botany and Distribution of Jelutong

A number of species of the genus *Dyera* have been described, but it seems probable that commercial jelutong is derived from not more than two species, *D. costulata* Hook. f. and *D. lowii* Hook. f. These are large forest trees which appear to be very similar, the former inhabiting dry land, and the latter being found in swampy areas. The first-named species occurs in Malaya; the second seems to be the important species in Borneo, though the first is also found there, while both occur in Sumatra.

From Malaya two species, *D. costulata* and *D. laxiflora* Hook. f. have been described, but Symington [12] seems to have successfully established that only one species, *D. costulata*, actually exists in that territory. According to Corson [13] three species, *D. costulata*, *D. lowii* and *D. borneensis* Pierre, have been reported from Sarawak. Burkill [10] suggests that the two latter may be identical, and constitute a species which is plentiful in Borneo, and which may extend to Sumatra and even be identical with *Alstonia polyphylla* Miq. Drees [11] describes jelutong as being derived from *D. costulata* and *D. lowii*, which occur in Sumatra, Borneo, Malacca and the islands lying between; the former is found on dry lands at altitudes up to about 2,600 ft., and the latter species grows only on marshland below an altitude of some 170 ft.

The jelutong tree commonly attains a height of about 150 ft. and a girth of about 10 ft., though some individual specimens may be fully 200 ft. tall, and girths of up to 26 ft. have been recorded. There is a large spreading crown, usually 100 ft. to 150 ft. wide and occupying rather more than half the height, with the lower portion of the stem bare [14]. The leaves are borne in whorls of usually six to eight; the flowers are small and white; and the fruit consists of two large cylindrical follicles about 1 ft. in length and an inch broad.

The wood is described as whitish, very soft and light, easy to work but not durable. It is excellent for pattern making and certain other purposes but is useless for structural purposes on account of its weakness and lack of durability.

In Malaya, according to Foxworthy [14] the tree (*D. costulata*) is found in flat country and low hills from sea-level to an altitude of about 1,400 ft., and on alluvial or laterite soil. Watson [15] reports that its distribution is essentially sporadic, there being on the average barely one mature specimen per three acres, but that recent silvicultural operations may lead to an increase in the density of this species. Foxworthy, writing earlier, considered that jelutong probably occurs in every district in Malaya, but placed the density even lower.

Corson (*loc. cit.*) has described the characteristic "jelutong

swamps" of Sarawak where *D. lowii* is found. The swamps are situated along the coast and vary in depth from ten to sixty miles or wider; where the beach is sandy they may extend almost to the sea-shore, whilst where mangrove swamps occur they commence further inland. The swamps lie almost at sea-level and are liable to fresh-water flooding with river water due to tidal action. Though wet, the land is never stagnant as there is always some flow of water. During the drier season of the year they may be almost free of water, but from October to March are very wet.

Jelutong appears to be more densely distributed in Sarawak and in the Netherlands East Indies than it is in Malaya. For instance, in Sarawak it has been reported that the best areas may contain as many as 12 trees per acre with a girth of about 5 ft. or more, though such a number is not commonly found.

Tapping of Jelutong

Watson [10] and Corson have recorded useful accounts of the tapping and preparation of jelutong as carried out by native producers, and according to the former authority jelutong is tapped in Malaya as follows:

"The most common method employed in the Malay Peninsula is to make a V-shaped cut embracing half the circumference of the stem, the sides of the V being inclined at an angle of about 45° to the vertical axis of the tree, and its base about 8 ft. above the ground. The instrument commonly used is a semi-circular gouge about 1 in. in diameter with which the bark is supposed to be removed down to the cambium, the latter being left intact. The cut is reopened (usually on alternate days) by the removal of a narrow strip from the upper and lower surface of the cut. The lower cut forms a channel, along which the latex flows into a bamboo receptacle. The handle of the gouge is socketed to enable it to be mounted on poles of varying length to suit the height of the tap. As the upper cut progresses up the stem it inclines more and more to the vertical, whilst the lower cut tends to flatten out. The latex from the upper cut has to flow over the whole tapped surface before it reaches the channel, so that a certain proportion coagulates on the cut, but the resulting loss is inconsiderable. The method appears to have originated in Sarawak."

On account of the sporadic distribution of jelutong in Malaya it is found to be difficult to control the activities of tappers, and outside forest reserves it is reported that they are very much left to their own devices. Within reserves exploitation is strictly controlled. A minimum tapping girth of 7 ft. is mentioned, which also corresponds to the felling limit for the jelutong tree, though this may be reduced at the discretion of the State Forest Officer [16]. Such a minimum tapping girth, even if reduced a little by permission is very high as compared to the practice prevailing elsewhere. The use of long-handled gouges is not regarded with favour either in

Malaya or in Sarawak, and in these countries their lengths must not exceed 5 ft. and 6 ft. respectively. In Malaya the erection of rough wooden stages for high working has been advocated. Watson records that the maximum thickness of bark that may be removed is $\frac{1}{4}$ in. a day, and gives the opinion that a 6-ft. tapping surface should last for at least 144 working days, i.e. for a year if treated with reasonable care.

As in chicle gathering, the jelutong collector in Malaya taps the trees on his outward journey, and collects the latex on the way back. Wooden boxes, waterproofed with a clay lining, are used to contain the latex after collection.

In Sarawak, trees of above 3 ft. in girth may be tapped. The tappers usually make paths of felled trees for working through the jelutong swamps. The Forestry Department's rules provide that the base of the tapping V cut may commence 3 ft. from the ground, and a clear space of untouched bark, 18 in. wide measured horizontally, must be left between the tapping faces. In certain instances, where a responsible licensee is concerned, tapping may be permitted on both sides of a tree provided that two clear spaces of 9 in. be left between the tapping faces. Such a provision allows regular tapping as each side may be tapped on alternate days.

Corson reports that a single labourer can tap between 25 and 30 trees a day and collect from 3 to 4 gallons of latex.

In addition to bamboo receptacles, cloth bags and palm spathes are also used in Sarawak to catch latex, and when work for the day is completed larger cloth bags are used to collect the material from the trees worked. Cloth bags are waterproofed with an extract obtained from a species of *Eugenia*.

A common practice is to tap the trees almost daily until the yield decreases, though no work is carried out on rainy days. Marshall [28] considers that periods of rest at monthly intervals would benefit the trees which often die under intensive tapping.

The available information on the question of the yield obtainable from jelutong trees under commercial tapping is somewhat meagre. According to Watson, high-yielding trees, 7 ft. in girth or more, will give about 20 oz. of latex a day, or about 400 oz. a month coagulating to 8 lb. of commercial jelutong. The same authority suggests that, estimating on a conservative basis, about 67 lb. might be produced from such trees in a year. However, information from another Malayan source places the yield of latex from trees of the size usually tapped by the Chinese at 10 oz. a day [17].

Preparation of Jelutong

Much work on the improvement of methods used in the preparation of commercial jelutong from the raw latex has been undertaken in Malaya, and a comprehensive account of the processes involved has been published by Georgi [18].

Jelutong latex is first coagulated. The coagulated material will

then be " refined " one or more times before it is finally exported. Refining consists in reducing the water-content by boiling.

The normal Malayan procedure is described as follows [28]. After collection the latex is coagulated in the jungle, and pressed. On reaching the jungle collecting centre a first boiling (refining) is made, and the partially refined jelutong is pressed into blocks for transport. At Kuala Lumpur the material is reboiled once or twice, i.e. further refined, and sent to Singapore.

Coagulation.—The first process in preparation is the coagulation of the crude latex, which should be strained before treatment commences, to remove leaves and other extraneous matter with which it inevitably becomes contaminated in the forest. Coagulation may be carried out in any convenient receptacle provided that no soluble iron is present or is introduced, as if this occurs brittleness is likely to develop in the material during storage, i.e. resinification will occur. Kerosene tins are the common form of receptacle employed, and if allowed to become rusty may contaminate the latex with iron ; care must be taken therefore to see that those used are in good order. Contamination may also occur through the water used to dilute the coagulant, and the collection of rain water for this purpose has been recommended.

Various substances have been employed alone or in mixtures in the coagulation of jelutong. Formerly, kerosene, to which had been added small quantities of alum and gypsum among other substances, was utilised in both Malaya and Sarawak. Alum and gypsum appear to be still largely used in the Netherlands East Indies. Alum has been described as an excellent coagulant, but its employment is said to have the disadvantage that refining must be effected within ten days. The use of acetic, formic and phosphoric acids has been developed in Malaya ; the last-named is recommended by Georgi as it has the special advantage of precipitating any traces of iron in the latex as insoluble iron phosphate, and its use is now approved by manufacturers in America and is generally advocated.

Georgi [18] has described the two methods of coagulation, by standing (cold process) and by boiling.

In the first and usual method the strained latex is left standing for a period of normally three days in a covered receptacle with the appropriate quantity of the coagulant added. If coagulation is incomplete at the end of this period, which is indicated by the serum being thick and sticky as opposed to slightly milky in appearance when a satisfactory coagulation has been obtained, the process should be left to continue a day or two longer as required.

In the second method the latex, with the added coagulant, is heated and permitted to boil for two or three minutes, being kept stirred all the time, after which the process will be completed. It is important that the correct amount of acid should always be added as an excess leads to a loss in the amount of coagulum

produced, while the receptacles must not be filled too full, otherwise these will froth over during heating. Although this second method has certain advantages it is not easily carried out in the jungle and has never been generally adopted [28].

The following table giving the amounts of the different acids that should be used in the two coagulating processes has been compiled from Georgi's recommendations :

Coagulant.	Quantity required. Cold process.	Boiling.
Acetic acid, 10 per cent.	4 fluid oz. per 5 gal. latex	1 fluid oz. per 6 gal. latex
Formic acid, 10 per cent.	1 fluid oz. per 2 gal. latex	—
Phosphoric acid, 1 part by volume to 19 parts water	1 fluid oz. per gal. latex	1 fluid oz. per 5 gal. latex

The coagulum thus produced is pressed into blocks, during which process much of the serum is removed, and the crude jelutong so obtained is kept in water, for preference running water. If stored in this way the material is kept soft, and soluble serum solids are gradually washed out. Should the blocks become coated with scum this can be removed with the aid of a brush. However, as has been described, Malayan jelutong will have normally received a first refining before removal from the jungle collecting centre.

Refining.—The refining of crude jelutong consists in boiling the material in water to remove the soluble serum solids. Refining may be carried out, as has been indicated, more than once and at different stages in the material's journey to Singapore, or other port of shipment. It is possible to go on refining, i.e. lowering the water-content of the material, until dehydrated jelutong is produced. The following is an account of the general method of refining and of the principles involved.

The blocks of raw or partially refined jelutong, which if dirty may be cleaned by paring off the outside layer, are cut into pieces and boiled for at least 15 minutes and until these have lost their original shape. During boiling the material is kept constantly stirred. When boiling is completed the jelutong, which is very hot, is removed by means of the wooden stirring paddles to wet boards or a wet cement floor, where it is pressed by trampling, cold water being poured over the surface to cool it sufficiently for working. The water also assists in washing out the soluble serum solids, and while the treading is in progress the labourers pick out any dirt or discoloured pieces that are seen. When trampling is completed the material is pressed into blocks, which may be 12 in. × 9 in. × 3 in. and weigh about 9 lb. ; these are again stored under water until the time of transport arrives. During transit the outsides of the blocks dry somewhat, and what has been termed a " skin " is in consequence formed on the surfaces.

Refining may be effected, as in jungle collecting centres, in iron pans heated directly by fires underneath ; elsewhere rather more elaborate equipment may be employed. Georgi states that jelutong suffers no deterioration from contact with iron at this stage.

Unless carefully prepared, jelutong is liable to serious deterioration on storage which may render the product valueless, though external discolouration due to fungal action is reported to be relatively unimportant. Resinification (a form of oxidation) has already been mentioned, while if the soluble serum solids are not properly washed out during refining sticky black spots will develop on storage, due to bacterial action, and eventually the blocks will become useless sticky masses.

Various oily preservatives have been quite commonly added by the refiners in both Malaya and Sarawak during boiling, with the object of coating the finished blocks with an air-tight skin, and to retard resinification. An emulsion of Castile soap and mineral oil was formerly recommended in Malaya, and has been employed in Sarawak ; a mixture of castor oil and ammonia has also been used, while some producers have their own secret preparations. Authorities now consider, however, that the use of such preservatives is unnecessary provided that proper care in jelutong preparation is observed, and their use is now discouraged.

Crude jelutong as produced by the cold process usually contains about 80 per cent. of water ; on refining the water-content is reduced to round about 45 per cent. or rather less, with a refining loss of approximately 40 per cent. of the original weight of the material. During the year 1936 moisture determinations were made at the Forest Research Institute, Kepong, Malaya, on 37 commercial consignments of jelutong, representing in all some 200 tons of the material. The water-contents so determined ranged from 33·8 to 42·9 per cent., and the average of these determinations was 38·1 per cent. [19]. Such results are probably typical of Malayan produce, but quite possibly are rather better than the standard of much jelutong produced elsewhere.

Marketing of Jelutong

Jelutong production is largely undertaken by the Chinese, and a large proportion of the crop is marketed through Singapore, where it is purchased by manufacturers representatives. The material has been sold on the basis of a water-content of 45 per cent., a premium being payable for any reduction on this figure, and a penalty exacted for any excess.

Considerable variation has been found to occur not only between blocks of the material taken from the same case, but also between different samples from the same block. Thus a standard method of sampling has been evolved and is described by Georgi [18].

In the sampling of a consignment, 10 per cent., with a minimum of four, of the cases are opened, and 5 per cent., with a minimum of eight, of the blocks are taken for sampling, the cases being selected, and the blocks numbered for this purpose according to a definite system. The blocks are then cut in half, and a wedge-shaped piece is cut out with an axe from each, weighing not less than a half

of 1 per cent. of the weight of the block; these pieces together form the samples for testing the consignment. The pieces are cut into thin strips, weighed, dried for 18 hours at a temperature of 105° C., cooled and weighed again, the difference in weight being taken as the water-content of the sample, which is used to determine the price to be paid for the consignment.

Previously it appears that the material was valued almost exclusively on water-content. More recently buyers have paid attention to the other qualities which have been described.

Formerly, all jelutong was shipped from Singapore, where much had been further refined, as refined material, the blocks being usually packed 36 to a case. However, dehydration of jelutong at Singapore was commenced in 1939, Borneo and Sarawak produce being the material so processed initially. Though it appears that the new process has not yet been universally adopted, it seems probable that a large part of the output may soon be so treated. In dehydration the jelutong is boiled in large vats with superheated steam until all water has been driven off and the resulting water-free gum reaches the consistency of syrup. This solidifies into blocks on cooling when poured into moulds [28]. The development of dehydration in the countries of origin will reduce the weight of material to be shipped by eliminating matter of no value to manufacturers. It will also have the important advantage of reducing the risk of deterioration during transport to, and storage in, consuming countries.

Watson [10] reports that the Malayan domestic material has the reputation of being the best on the market, fetching a higher price than the jelutong of other producing regions, notably that of Sarawak and Borneo. The Bornean species, *D. lowii*, has been described as yielding a lower-grade product than the Malayan species, *D. costulata* [19], though the jelutong from the two species is said to be indistinguishable by the layman. It would seem probable, however, that the methods of handling and coagulating the latex are more efficient in Malaya, and this may account, at least in part, for the recognised superiority of the final product of that country. Marshall considers that the development of dehydration will tend to cancel this advantage.

Production and Trade in Jelutong

The territory of Borneo, in the Dutch East Indies, is the most important producer of jelutong. Second place has been taken by the exports of Sarawak, though production in this country has tended to fall during the past ten years, it seems on account of many trees being killed by excessive tapping. Next in order comes Malayan domestic production, and fourthly that of Sumatra. A smaller quantity is derived from Brunei, while both North Borneo and Thailand (Siam) have provided unimportant amounts.

The chief feature of the jelutong trade is that most of the world's

production passes through Singapore and that the vast bulk of the output is taken by the United States.

Exports from the Netherlands East Indies, Sarawak and Brunei have been as follows during recent years:

EXPORTS OF JELUTONG
(*in long tons*)

Netherlands East Indies

To	1935.	1936.	1937.	1938.	1939.
Singapore	3,680	6,458	6,135	7,628	6,322
United States	910	672	849	603	742
Japan	95	82	118	—	—
Other Countries	16	10	1	—	2
Total (*tons*)	4,701	7,222	7,103	8,231	7,066
Value (*Guilders*)	260,495	523,599	566,702	942,366	660,388

Sarawak

	1935.	1936.	1937.	1938.	1939.
Jelutong, raw	259	214	58	386	100
,, refined	1,354	1,327	1,299	1,617	1,135
,, dyera and pressed	—	—	—	—	11
Total (*tons*)	1,613	1,541	1,357	2,003	1,246
Value ($)	451,929	475,022	661,493	739,842	397,317

Brunei

	1935.	1936.	1937.	1938.	1939.
Total (*tons*)	133	167	151	166	*
Value ($)	45,060	69,669	68,016	81,948	*

* *Not available.*

The statistics of the imports and exports of jelutong to and from Malaya illustrate the importance of the trade handled at Singapore.

BRITISH MALAYA

Imports of Jelutong
(*in long tons*)

From	1935.	1936.	1937.	1938.	*1939.
Sarawak	1,727	1,582	1,305	2,080	1,208
Brunei	24	106	174	175	141
Netherlands East Indies—					
Borneo	3,577	5,616	5,653	5,960	5,106
Sumatra	46	458	275	1,350	888
Other Countries*	6	19	—	45	21
Total (*tons*)	5,380	7,781	7,407	9,610	7,364
Value ($)	962,405	1,249,154	1,713,494	2,106,208	1,301,635

* *North Borneo and Thailand.*

Exports of Jelutong
(*in long tons*)

To	1935.	1936.	1937.	1938.	1939.
United Kingdom	6	8	2	13	14
United States	3,279	4,494	5,545	7,526	5,159
Japan	70	56	29	—	—
Germany	28	44	19	2	6
Other Countries	39	21	10	48	17
Total (*tons*)	3,422	4,623	5,605	7,589	5,196
Value ($)	1,186,055	1,679,314	3,214,967	4,081,610	2,527,144

Apart from the predominance of the United States market in the jelutong trade, an interesting feature of these statistics is the increase in Sumatran production during the past five years.

Malayan domestic production, for all States, Federated and Unfederated, has been in the neighbourhood of 1,000 tons per annum for a number of years. The actual quantities produced during the last four years for which statistics are available have been as follows:

British Malaya—Domestic Production of Jelutong

	1935.	1936.	1937.	1938.
Total (*tons*) . .	649	1,010	1,477	2,394

These figures must not be taken as necessarily indicating that production is now increasing; prior to 1935 a succession of years produced about 1,000 tons each, though earlier the outturn was lower. Actually it is considered that production is more likely to fall than rise in the early future, and until wastage of large tappable trees is eventually made up by the regeneration work now in progress [19]. However, this may be a rather pessimistic view, though increased production cannot be anticipated. The large crop of 1938 is accounted for by the enhanced value of the product during 1937, which led to exploitation in the less accessible areas. Within Malaya, Pahang is responsible for roughly half the total production, other States yielding important quantities include Perak, Selangor, Negri Sembilan and Johore.

Trade and production statistics, except those of Sarawak, do not differentiate between refined and crude jelutong. The loss in weight that occurs during the process of refining would appear to account for the fact that, despite the appreciable local production, the volume, but not of course the value, of imports of the material to Malaya has been largely in excess of the volume of exports. Much Netherlands East Indies and other semi-refined jelutong has been imported to Singapore for further refining there. Now such jelutong is likely to be dehydrated in Singapore, and the loss in volume of the exports will probably be even greater.

Most of the world's production of jelutong is taken by the United States, and consignments finally reach that country through Singapore or to a much lesser extent direct from the Netherlands East Indies. Thus the statistics of imports of the material to that country provide a most useful and relatively accurate summary of total world production of jelutong.

United States—Imports of Jelutong
(*in lb.*)

From	1935.	1936.	1937.	1938.	1939.
British Malaya	9,718,596	11,257,896	13,563,516	13,370,502	11,947,801
Netherlands East Indies	2,924,900	2,546,647	2,358,621	7,085,193	2,925,648
Total (*lb.*)	12,643,496	13,804,543	15,922,137	20,455,695	13,873,449
Value ($)	1,063,126	1,296,364	2,017,786	2,944,504	1,603,418

In the above statistics of United States imports of jelutong, an exceptionally large figure is recorded for the quantity derived from the Netherlands East Indies during 1938, no such quantity being shown in the corresponding return for these territories as destined for the United States. Moreover, it is apparent that much of this jelutong is included in the Malayan exports of that year and thus passed through Singapore. Actually a large proportion of the Malayan annual export is normally comprised of re-exports which are not separately recorded, and which appear in the United States returns as from Malaya.

Similarly, the annual quantities of the material recorded as exported to the United States in the Netherlands East Indies trade returns, are less than those shown by the former country as received from the latter, in some recent years to the extent of approximately a million pounds. Thus it appears that in addition to the jelutong recorded in the Netherlands East Indies as destined for the United States, some, though a relatively small proportion, of the quantity recorded as destined for Singapore actually goes direct to the United States.

World production of jelutong, as indicated by the imports of the material to the United States, reached a peak of some 50 million pounds per annum during the years 1910 and 1911, and thereafter fell until about the year 1921, though in certain individual years during this period large quantities were produced. A second peak production year was attained in 1929, when some 18 million pounds were imported; while during the period 1923-29 the United States imports of jelutong were roughly 50 per cent. higher than those of chicle. In 1930 and 1931 imports of both materials were approximately equal at about 13 million pounds per annum. The third peak year was 1938, when some 20 million pounds were taken by the United States, and during the period 1932 to 1938 imports of jelutong were about double those of chicle. In 1939, the record year for chicle production, imports of the two materials were once again approximately equal.

Possibility of Plantations of Chicle and Jelutong

Very little seems to have been done to investigate the possibilities of establishing plantations of chicle, and it appears doubtful if these will ever be developed. Heyder [4] reports that the trees cannot be tapped to give any commercial yield before they are from 25 to 30 years old, while good yields are not obtainable until trees are probably some 40 to 50 years old. There is possibly more prospect of improvement of chicle forest by silvicultural treatment, some, though it would appear limited, experiments in this direction having already been undertaken.

In the case of jelutong a few experimental plantings have actually been made, though whether these will lead to any extensive plantations is again doubtful. A seven-year-old plantation in

Sarawak was reported recently to be making good progress, though not yet tappable. The best trees in a small trial planting in Malaya had attained a girth of 18 in. at the end of five years. Watson [15] is very doubtful of the prospects for jelutong plantations, as their establishment is difficult and slow, and the market for the product too limited for them to be likely ventures. This authority considers, however, that plantations run by the actual consumers of jelutong might have a future. The yields obtained from the experimental tapping of jelutong trees in Malaya varying in girth from 18 in. to 4 ft. were not encouraging, and did not suggest that plantation trees could be tapped at an early age.

It seems likely that the exploitation of jelutong will continue to be a forest industry, relying for its further development on the improvements that it seems may be effected by silvicultural treatments, and by wider use of better methods of preparation.

Composition of Chicle and Jelutong

Relatively little detailed work has been carried out on the chemical composition of these materials. The fullest particulars are given in the following old analysis of chicle by Prochazka and Endemann [22].

	Per cent.
Arabin	10·0
Calcium	9·0
Sugar	5·0
Water-soluble salts	1·0
Total constituents soluble in boiling water	25·0
Resins—Alban	33·75
,, Fluavil	22·5
Hydrocarbon (gutta) soluble in ether	6·0
,, ,, insoluble in ether	12·75
Total constituents insoluble in water	75·0

Heyder [4], quoting an analysis of raw chicle made by one of the American companies operating in British Honduras, gives the resin content as 61·3 per cent. and the gutta as 14·3 per cent., on a dry basis.

Jelutong as marketed consists essentially of moisture, resinous substances and caoutchouc. On a dry basis the product contains approximately 80 per cent. of resinous materials and 20 per cent. of caoutchouc. The dried material also contains about 0·06 per cent. of ash.

The water-content of refined jelutong has already been referred to; this appears to vary from about 35 to 45 per cent. according to the method of preparation.

Other Chicle-like Materials

A number of materials may be employed to some extent in the

preparation of chewing gum bases, though on account of the fact that the recipes for such bases are kept secret it is difficult to judge the extent to which these substances may be used. In fact, certain materials which have been described by some authors as chewing gum base ingredients may be actually very little employed in the chewing gum industry.

The proprietary chewing gum bases may be said to consist of a mixture of blended gums, and the proportions of the various ingredients used are understood to vary according to the type of base required. Possibly the blends are also variable according to the availability of supplies of the different materials employed.

Chewing gum manufacturers would, it appears, be interested in samples of any gums, from latex producing plants, if these meet the requirements detailed by Barron (see page 300), and are obtainable in sufficiently large quantities. They are only concerned with the non water-soluble portion of such gums, and experimental material could be advantageously boiled in steam jacketed pans to remove all water.

Of chicle-like materials, crown gum, which is produced from the latex of the closely allied species, *Achras chicle*, is not shown separately in trade returns, and may, indeed, be included with chicle in the export statistics. It is not possible, therefore, to estimate the quantity that may be employed, though there are grounds for believing that the product does not give a very satisfactory gum-base, or at least that it can only be employed, if at all, in small proportions. This was the view of a firm of sweet manufacturers to whom a sample of British Honduras crown gum was submitted by the Imperial Institute a few years ago [27].

Venezuelan "chicle," which in some recent years has been imported by the United States in small, though quite appreciable amounts, has already been mentioned. One authority has reported that the use of a proportion of a Colombian gum has been found essential to the production of certain types of chewing gum [23], several species according to Vander Laan [18] may be the source of this gum. A species of *Couma*, *C. guatemalensis* Standl., from Guatemala, has recently been noted as a possible commercial gum-yielder [24].

According to Record [3] certain species of *Dipholis* are recognised as sources of chicle gum in South America. *D. stevensonii* Standl. is a large tree occurring in British Honduras, the latex of which is used for chicle, and is called chicle faisán, faisán being the local name of the tree. There are two varieties, red faisán, of which the latex is said to be equal to that of *A. zapote*, and white faisán, which gives a high yield of lower quality latex. Another minor source of chicle gum is *D. salicifolia* A. DC. It is also reported that the latex of *Brosimum alicastrum* Sw., which occurs in the chicle-producing regions, is sometimes used as an adulterant. This tree is known as the breadnut in Jamaica. Hummel [7] states

that the latex of several trees, including *Trophis americana* Linn., may be used as chicle adulterants.

From Nigeria, Nigerian gutta or red Kano gum, derived from Gamji trees (*Ficus platyphylla* Del.) has been used in the manufacture of chewing gum bases, and in 1937-38 some half-million pounds were purchased for export to the United States [29]. However, the demand for this purpose subsequently ceased, though there appears to be some prospect that the material may eventually become established as a gum-base ingredient.

The mixing of gutta hangkang (*Palaquium leiocarpum* Boerl.) and gutta ketiau (*Ganua motleyiana* Pierre) with jelutong in the production of chewing gum base has been referred to; these guttas are produced in large quantities in the Netherlands East Indies. It appears that various "lower" guttas and balatas may be used for this purpose [25]. Recently, gutta pulai (*Alstonia* spp.) has been favourably reported on as a possible chewing gum base material. It is available in both Malaya and North Borneo, and no doubt also occurs in other jelutong-producing territories. According to Marshall [28], however, the yield of latex obtained from this tree is a discouraging feature.

Latex from trees of *Euphorbia* spp. in South Africa has been described as a likely material, but whether it has been actually utilised commercially in important quantities is not clear [26].

According to Barron [21] attempts have been made to produce a chewing gum base from rubber mixed with other substances, but difficulties seem to have been encountered in producing an entirely satisfactory base with this material as the principal ingredient. The same authority states that a certain proportion of guayule (*Parthenium argentatum* A. Gray) is used in chewing gum bases.

In conclusion, it seems that chicle-like materials may be grouped into the following main categories. Those such as chicle faisán, and possibly also crown gum, which may be marketed as commercial chicle, the purchaser either obtaining a satisfactory substitute or one of lower quality for which possibly less is paid; secondly, materials of eastern origin, i.e. jelutong and the various guttas; thirdly, materials such as red Kano gum and Colombian chicle; and fourthly, adulterants of chicle which it seems can generally be readily detected and which appear to be of little real importance.

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NOTES

Cultivation of Castor Seed in Brazil.—Of the two chief countries exporting castor seed (*Ricinus communis* L.), India and Brazil, the latter has become increasingly important in recent years on account of greater proportions of the Indian crop being utilised in the country of origin. In 1931, for example, India exported 117,000 tons of the seed and Brazil 19,000 tons. By 1938 the position had completely reversed, India exporting only 9,000 tons in that year, whilst the Brazilian exports had risen to 124,000 tons.

In Brazil the crop is considered to give the best results when grown in a moist tropical climate with the rainfall well distributed over the year. Even in a tropical country it does not do well at too high an altitude, or under insufficiently damp conditions; whilst if the climate is too cold, although a satisfactory vegetative growth may be obtained, the yield may be adversely affected.

The crop is cultivated in the agricultural zones of the north-eastern states, in the same area in which maize is widely grown, and its cultivation has also spread to the south of the country. In the valley of the San Francisco River the castor bean grows wild and the produce of the wild plants is harvested. It is also cultivated in this region.

The crop does well in the coastal districts, and in these areas it may, in the absence of frost, persist for several years. In such localities a tall growing variety may be employed. The plant is reported to be intolerant of a heavy dew-fall, and may be adversely affected by low temperatures even in the absence of actual frost.

Although the castor plant may survive for from five to ten years it is normally cultivated as an annual, though in some cases it appears that the crop may be left for two seasons. It is often grown in rotation with cotton, in which case it is advised that a green-manure crop should be taken in between.

Three general types of the plant are recognised, the tall, medium, and short. These vary in height from 5 ft. up to some 30 ft. or more. The seeds are from $\frac{1}{3}$ in. to 1 in. in length, with many variations in colour.

In normal circumstances it is the short or "low" types that are cultivated, and of these two varieties "Caturra" and "MC" are mentioned as being useful kinds, and also as being reasonably resistant to frost. A number of selected strains of the different types have also been produced by the Agricultural Institute, Campinas, S. Paulo.

An important point in choosing a variety is that the husks should not split too readily so that a large proportion of the crop is lost before harvest. Generally speaking the short varieties do not split before harvest. With these the seed weight is roughly half a gram, and the oil content is about 50-60 per cent. A medium variety is "Bourbon," the seeds of which have an oil content of about 63 per cent. The seeds of the tall varieties average round

about a gram in weight. A tall variety whose seeds do not split in the field is "Zanzibar." In general, however, the tall varieties have this defect. An additional disadvantage of the tall kinds is the difficulty encountered in harvesting due to their great height. Also as a general rule the oil-seed trade does not like the large seeds.

In general, results depend much on choosing the right variety. This can only be done by tests in the country of production. It has been found, for example, that varieties which give satisfactory results in one district may be comparative failures when tried in a different locality.

The castor plant will grow in almost any soil, but for profitable cultivation it is necessary to have good average land. Thus a sandy loam, containing humus and lime, is found to be satisfactory. Strongly calcareous, clay, peaty, sandy, waterlogged or cold soils are all less suitable, though excessive dampness can be corrected by drainage. The crop does well on flat valley soils, and on land bordering rivers.

Soils deficient in lime should be lightly limed about every three years. Freshly cleared forest land may be most advantageously first utilised for other crops as otherwise the castor plant tends to run too much to foliage. In any case the land should be capable of ploughing to a depth of about 9 in.

It is suggested that as castor is an exhaustive crop it is not well suited to inter-cultivation. However, in India, the crop is not normally grown as a pure stand, but is commonly intercultivated, or grown round the borders of the farms.

The castor crop makes good use of farmyard manure or of compost, and has a high nitrogen requirement. Green manure crops such as mucuna and crotalaria may be employed with advantage to save the cost of other fertilisers.

It is calculated that a crop of 1,800 lb. of castor seed per acre removes from the soil approximately 54 lb. of nitrogen, 22 lb. of phosphoric acid, 16 lb. of potash and 5 lb. of lime. A suggested manurial dressing is 8 tons of farmyard manure plus 90 lb. each of superphosphate of lime and potassium chloride per acre. Alternatively, 900 lb. of castor seed cake may be employed with 180 lb. of superphosphate of lime and 90 lb. of potassium chloride. Manuring must be adapted to the requirements of the particular soil, but a complete manurial dressing is recommended to obtain the best results.

Before the crop is sown the land should be ploughed twice in different directions and a good seed bed prepared. Authorities seem to agree that a thorough and deep cultivation of the soil prior to planting is advisable, and it is probably essential to the profitable cultivation of this crop under Brazilian conditions. The seed may be drilled but it is usually planted in rows by hand; it should not be sown broadcast.

In central and southern Brazil sowing takes place during the

months of September and November, for preference after a spring rain. The spacing adopted varies according to the type, and also to some extent with the fertility of the soil, the wider of the following spacings being employed on rich land :

Short types . .	40-80 in. × 70-80 in.
Medium types .	70-100 in. × 90-120 in.
Tall types . .	80-120 in. × 120 in.

Three to four seeds are put in at each stand and are covered to a depth of about 2 in. The crop is thinned to one plant per stand as soon as it is strong enough, i.e. when the plants are about 1 ft. in height. With the short types from 5 lb. to 7 lb. of seeds is required to plant an acre, and an average return is given as 1,600 lb. per acre, though the yield may be as low as 700 lb., and as high as 2,650 lb. per acre in exceptionally favourable circumstances.

The land should be kept free from weeds by cultivation until the crop is approximately 40 in. in height, at which stage the castor plants shade the land. It is advised that the plants should be topped when about 3 ft. in height, though not all authorities consider topping necessary with the short types. This operation serves to keep the bushes low, which facilitates harvesting.

At harvest the capsules are removed from the plants by cutting and the seed may be separated from the husks by beating at this time. Varieties such as "MC," with which shedding in the field does not occur, are best left until all the fruits are ripe.

The crop is quite frequently harvested when about three-quarters of the fruits are ripe ; the remaining capsules will ripen during drying. It is important, however, not to cut the fruits earlier as there will be a loss in the yield of oil obtained if too high a proportion of unripe fruits are harvested. After harvest the fruits are spread out in the sun to dry and split. Splitting may have to be assisted by threshing, though in normal circumstances, if the crop is picked in dry weather and spread out in the sun, the capsules split satisfactorily. The seeds can be readily separated from the husks, though the crop may be beaten to facilitate this operation. If the crop is harvested when damp trouble in separation may be experienced. With large plantations some form of artificial drying equipment may have to be provided on account of the size of crop to be handled.

The presence of broken seeds and rubbish lowers the value of the seed, and these are usually removed by winnowing before the crop is bagged. The seed may be graded according to size, and for storage purposes a dry ventilated building should be employed.

While many insects live on the castor plant in Brazil it is reported that none of these do any damage of serious economic importance. There are no widespread diseases affecting the castor crop in that country, though in certain circumstances severe damage is experienced from *Botrytis* sp., while leaf spot is common.

The material contained in this note is largely derived from the following publications:

"Rizinuskultur in Brasilien." *Hochland Ostafrika*, 1937, **7**, 236-240.

"Die Rizinuspflanze." *Tropenpflanzer*, 1939, **42**, 337-343.

"A Mamoneira." By P. T. Mendes. *Bol. No.* 19, *Inst. Agron., S. Paolo*, 1938.

Dried Onions.—The Imperial Institute has received an inquiry from a firm in this country regarding the possibility of obtaining supplies of dried onions in the British Empire. Until the commencement of the War the firm obtained its supplies from Southern Europe, but these supplies are now cut off, and it has been suggested that attempts might be made to obtain the product from Empire sources.

The trade in dried onions developed after the last war, and there is now a big demand on the Continent, where the material is used for soups, flavouring, etc. Last year the demand in this country for dried onions was in the neighbourhood of about 400 tons, and this demand is expected to increase in the future. It should be mentioned that one ton of the dried material represents about 10 tons of the whole fresh onions.

Dried onions are shipped here in the form of slices, kibbled, or as powder, and are packed in tin-lined cases of 1 cwt. or 2 cwt. each, although other forms of packing might be suitable provided there was no deterioration in quality during shipment. Before the war the material, in any of the above forms, was fetching between 65*s*. to 70*s*. per cwt., but is now worth about 150*s*. per cwt., landed London (August 1940).

The method of preparing the onions is briefly as follows:

The onions should be trimmed and peeled by hand and then cut into very thin pieces, since thick pieces dry very slowly and are apt to darken on drying. Before drying the slices may be immersed in a 5 per cent. salt solution for three to five minutes, and such immersion is stated to reduce the tendency of the onion to darken during drying and later in storage.

During drying the temperature should not be allowed to go beyond 140° F., since above this temperature the slices tend to darken and lose their flavour. The drying is usually done on trays in tunnel driers, although kiln driers such as those used for copra might be suitable for the purpose. The time required for drying is between 5 and 10 hours, and the finished material should be dry and crisp with a moisture content between 5 and 7 per cent. The slices should be turned at intervals during the drying to hasten the process. Where it is desired to produce the powder, the slices are ground by hammer mill after drying.

Sun-drying is said to give less satisfactory results than artificial drying.

The Imperial Institute would be glad to receive samples of dried onions from Empire sources with a view to submitting them to the trade for a report on their market possibilities.

Storage of Foodstuffs in the Colonial Empire.—In the memorandum on this subject, published in the last issue of this BULLETIN, reference was made (p. 176) to spraying equipment suitable for dealing with insect infestation in storage buildings. To the list of firms who supply such equipment should be added Andre (Components) Ltd., of Putney, who manufacture the Phantomyst spraying apparatus, which is widely employed for applying very finely atomised insecticides in combatting pests of stored tobacco, cocoa, etc., as well as for general sterilization purposes.

The Empire Cotton Growing Review.—In the October number of the *Empire Cotton Growing Review* it was announced that the regular quarterly publication of the *Review* would be suspended for the duration of the war. It has, however, been decided that in order to obviate any gap in the abstracts from scientific, commercial, and technical literature, which have always formed an important section of the *Review*, it is desirable to publish from time to time issues consisting entirely of abstracts generally similar to those formerly comprised under the heading of "Notes on Current Literature." Two such numbers are being issued this year, in June and December, and the price of each number will be 1*s*. 3*d*. post free. They are obtainable from the publishers of the *Review*, Messrs. P. S. King & Son, Ltd., 14 Great Smith Street, London, S.W.1. The first of these special numbers contains in its 84 pages 340 abstracts and a table showing the Empire Cotton Crops for the years 1929-39, other than India.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

Soils and Manures

Montserrat.—The report of Mr. W. E. Bassett, Curator, for the half year ended June 30, 1940, makes further reference to the observational experiment in connection with soil erosion control which has been described in earlier reports. During March and April 1940 this experiment was re-planted, some alterations being made to the layout. The three main treatments, viz., stone wall terracing, strip cropping with grasses, and contour ridging, remain

the same. Each treatment has now been divided into three belts running up and down the slope, one belt in each treatment being planted with one of the following crops: cotton, sweet potatoes and sugar cane. The kinds of grasses used in the strip cropping treatment have been reduced to three. They are lemon grass, sugar cane and guinea grass, one of these grasses occurring in all the strips throughout any one of the belts running up and down the slope in the strip cropping treatment.

Nigeria.—According to the half-yearly report of the Chemical Section, Southern Provinces, for July to December 1939, a series of manurial experiments was started in 1937 in a number of stations in the Southern Provinces. Owing to a variety of difficulties a really conclusive result has not yet been obtained from most places. But on the other hand, the figures produced so far are most interesting and fall in with the prevalent ideas on the soils of the country extraordinarily well. On Moor Plantation, where there is a comparatively neutral soil with a rather low content of organic matter, the response to artificial manures is very largely in favour of phosphorus. On the extremely acid soils of the Eastern Provinces, where the organic matter content is very much higher than on Moor Plantation, the response to phosphorus is practically nil—presumably because it is fixed in the form of ferric phosphate—but the reaction to nitrogenous manure is certainly significant. The Department is just finishing the second and third years' results on this type of experimentation and it is hoped that it will be possible to correlate these results in a statistical manner when the series is complete.

INSECT PESTS

Tsetse Fly

Nigeria.—Mr. F. D. Golding, Senior Entomologist, in his report for the half-year July to December 1939, states that in connection with tsetse research, the six unit farms in the Ilorin Province were visited in July. The degree of fly-cattle contact did not seem to be great and has been reduced by the practice now adopted of feeding the cattle in their pens.

In July an assistant visited Umuahia to investigate the reasons for conflicting reports which had been received from time to time concerning the abundance of tsetse flies on the farm. He found that the local fly was *Glossina tachinoides* Westw. and that, while none could be found near the cattle or sheep pens, tsetses were always present in some nearby pig pens. Two local men were trained in fly work and are now making weekly observations on the incidence of *Glossina*.

Fly counts were made at various localities in the Benin and Warri Provinces and on Lagos Island.

Pests of Stored Products

Nigeria.—Mr. Golding's report also states that since the outbreak of war observations have been made on insect pests attacking ground-nuts, cowpeas, maize and stockfish. In October some 1938 crop ground-nuts in the export stores at Apapa were found to be heavily infested by *Tribolium castaneum* Hbst., and also to contain larvae of *Ephestia cautella* Wlk. On the other hand, some of the 1939 crop, examined at Apapa in December, was found to be entirely free from insect attack. No evidence has yet been obtained that the Bruchid beetle, *Pachymerus cassiae* Gyll., is a pest of ground-nuts in Nigeria, although specimens of *P. longus* Pic. were received from Muri Division in July, where they were infesting ground-nuts in native " tumbus."

Insecticides

Malaya.—Mr. H. T. Pagden, Acting Senior Entomologist, in his half-yearly report for January to June 1940, states that neither derris sprays, with or without agral, nor pyrethrum sprays or dusts have given satisfactory control of *Plutella* on cabbages. Nicotine extract, 0·05 per cent., has given better results.

Beverages

Cacao

Nigeria.—Mr. F. D. Golding, Senior Entomologist, in his report for the half-year July to December 1939, gives the following statement relating to research on cacao.

In August an investigation was made of cacao farms near Owena in the Ondo Province. The first records were obtained of *Helopeltis* attack on cacao in Nigeria and, in addition, three species of Pentatomid bugs were found attacking the pods. All of these insects were also found feeding on *Solanum verbascifolium*, which is the first plant to appear after the forest has been cleared for cacao planting. *Sahlbergella theobroma* Dixt. was found attacking young cacao and young citrus on the Government Farm, but was not observed on young cacao on native farms. At Ibadan, this species has been recorded on young citrus on several occasions, but never on cacao, which is about 600 yards away from the citrus area. *S. singularis* Hgl. was present on pods in small numbers, but considerable patches of trees with dead brown leaves were found on several farms which had almost certainly been attacked by this species earlier in the year. It was discovered that both *Helopeltis* adults and nymphs were attacking shoots as well as pods, and in the future it is hoped definitely to establish the relative importance of *Helopeltis* and *Sahlbergella*.

In April and May 1939 an extensive search was made for *Sahlbergella* in the vicinity of Ibadan; only one nymph could be found. During the succeeding months the population gradually

increased until, in late October, adults and nymphs could be found in fair numbers on most farms. On one small isolated plot of 70 trees very serious damage was done to the shoots and foliage; there were rock outcrops in this plot and the trees were unhealthy. Elsewhere damage to shoots was negligible, and the *Sahlbergella* population on the pods began rapidly to diminish in December.

The cacao *Helopeltis* was also found in two localities within 13 and 22 miles of Ibadan; but has not yet been observed on farms in the immediate neighbourhood of that town. *Solanum verbascifolium* is common in the *Helopeltis* areas and very rare near Ibadan.

Cereals

Rice

Malaya.—Mr. H. T. Pagden, Acting Senior Entomologist, in his report for the half-year January to June 1940, states that with regard to the prevention of insect attack in stored padi, experiments are in progress to determine the limits for moisture content of the grain and of the atmospheric humidity in the store.

Tests with carbon dioxide as an asphyxiant for insects infesting stored grain have been made. It was found that exposure for three weeks in a concentration of 90 per cent. carbon dioxide was necessary to kill all stages. Shorter exposures resulted in the emergence of a generation of *Calandra* within one month of clearing the atmosphere.

Arrangements are being made for sampling the atmosphere within large stacks of grain with a view to determining the concentration of carbon dioxide and its inhibitory effect on insect activity.

Recent extensive sampling has shown that *Rhizopertha dominica* F. is the most numerous insect in stored padi; second is *Lophocateres pusillus* Klug, and third *Calandra oryzae* L., the ratio being 8 : 3 : 1, but the second does not appear to do much damage. In stored rice *Calandra* is more numerous than *Rhizopertha*.

Pulses

Pigeon Peas

Nigeria.—Mr. J. K. Mayo, Senior Botanist, Northern Provinces, in his report for the half-year July to December 1939, states that pigeon peas are the staple food of some pagan tribes in the southern part of Plateau Province but are rarely grown elsewhere in the Northern Provinces. Experiments on the Department's farms have now shown that this plant will flourish in all parts of the Northern Provinces, and yield more seed than any other legume yet tried except ground-nuts (apart from ground-nuts the legume most commonly grown is the cowpea). The crop is being tried in various ways interplanted and alone, usually ratooned, and propaganda has been started to encourage the Mohammadan tribes to eat it.

The local variety is a mixture of types, all of which have

white seeds. Six Pusa strains are under trial, three of which have coloured seeds. Yields of 400 to 1,000 lb. of seed per acre have been obtained.

Root Crops

Sweet Potatoes

Montserrat.—Mr. W. E. Bassett, Curator, in his report for the half-year ending June 30, 1940, states that three new varieties of sweet potatoes, " Black Rock," V.52 and B.20, recently introduced from Trinidad, have been grown in a small trial side by side with " Red Six Weeks " and " Three Months," two popular local varieties. So far the new introductions appear to give higher yields than the local varieties.

Experiments have been carried out in the storage of sweet potatoes in clamps. The results have not been uniform. Some lots have kept very well for two months, while in others most of the tubers have decayed in the same or a shorter period. These experiments are being continued.

Fodders

Malaya.—The report of the Agricultural Department for the half-year January to June 1940 contains the following particulars concerning the first year's results from the randomised manurial experiment laid down at the Central Experimental Station, Serdang, with Napier grass (*Pennisetum purpureum*) and Merker grass (*P. merkeri*) and to which reference was made in the half-yearly report for July to December 1939 (this BULLETIN, 1940, **38**, 39). The summaries of the cultural work have been furnished by Mr. T. D. Marsh, Senior Agriculturist, and notes on the chemical composition by Mr. Gunn Lay Teik, Acting Senior Chemist.

Species of Grass.—Napier grass gave a slightly greater yield than Merker grass, the figure for Napier being 13·8 tons per acre compared with 12·6 tons for Merker grass.

The slightly higher protein content and the slightly lower fibre content for Napier grass compared with Merker grass reported after 6 months cutting have been maintained as the following figures for grass cut at eight-weekly intervals show.

	Protein. (Moisture-free basis.)	Fibre.
	Per cent.	*Per cent.*
Napier grass . .	9·7	32·9
Merker grass . .	8·6	34·8

Soil.—The yields on the flat light land of low fertility are slightly higher than those on the sloping land of medium texture.

There was a slightly higher protein content for both grasses grown on sloping land of medium texture compared with flat land

of low fertility as the following figures, calculated on a moisture-free basis, for grass cut at eight-weekly intervals show.

	Protein. (Moisture-free basis.) Napier Grass. Per cent.	Merker Grass. Per cent.
Sloping land of medium texture	10·0	8·9
Flat land of low fertility	9·4	8·3

In the case of flat land of low fertility the higher average phosphorus content reported after 6 months cutting has been maintained, as is shown by the following figures for Napier grass.

	Phosphorus (calculated as P_2O_5). (Moisture-free basis.) 6 weeks. Per cent.	8 weeks. Per cent.	10 weeks. Per cent.
Sloping land of medium texture	0·62	0·63	0·57
Flat land of low fertility	0·80	0·79	0·75

Interval of Cutting.—The approximate yields for the three cutting intervals of 6, 8 and 10 weeks have been 11·6, 13·1 and 15·0 tons per acre respectively. Increases in yield for 8 and 10 weeks intervals over a six-weekly interval of cutting are 13 and 29 per cent. respectively.

No particulars have been furnished as to the influence of different intervals of cutting on the composition of Napier grass and Merker grass, but Mr. Gunn Lay Teik reports that harvesting trials with Guatemala grass (*Tripsacum laxum*) are in progress. The grass is being cut at six-weekly, eight-weekly, ten-weekly and twelve-weekly intervals. There is a marked decrease in the protein content of the grass with an increase in the interval of cutting although the increase in the fibre content is not as great as anticipated. The results of analysis for average samples of the grass cut at the different intervals are given below.

Interval of cutting. Weeks.	Protein. (Moisture-free basis.) Per cent.	Fibre. Per cent.
6	12·0	34·5
8	8·2	34·4
10	4·9	35·0
12	5·2	37·5

Manurial Treatment.—Increases in yield are approximately proportional to the amounts of manure applied. Taking a basal yield of 10·6 tons per acre with an application of 5 tons of cattle manure an increase of approximately 12 cwts. per acre has been obtained for each additional ton of cattle manure applied over the above rate. The chemical composition of the grass is not influenced by increasing applications of cattle manure.

It is also reported that an investigation has been commenced at Serdang to study the relative values of indigenous pasture grasses for grazing purposes.

As a result of preliminary trials the following have been selected for extended trials and stocks of planting material are being multiplied accordingly: (a) *Axonopus compressus*, (b) *Panicum repens*, (c) *Apocopsis siamensis*, (d) *Paspalum conjugatum*, (e) *Digitaria longiflora*, (f) *Amphilopsis glabra* and (g) Rumput tadak embun. The last-named grass has not been botanically identified.

The chemical composition of the various grazing grasses are shown in the following table. In order to effect a fair comparison between the grasses the figures have been calculated on a moisture-free basis.

Name of Grass.	Protein.	Fat.	Nitrogen-free Extract (by difference).	Fibre.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Axonopus compressus .	16·5	1·2	44·0	26·8	11·5
Panicum repens . .	24·1	2·0	37·8	22·7	13·4
Apocopsis siamensis .	12·7	2·1	48·1	26·8	10·3
Paspalum conjugatum .	15·6	1·6	43·5	25·1	14·2
Digitaria longiflora .	20·0	1·7	43·1	16·9	18·3
Amphilopsis glabra .	13·4	2·2	44·3	30·1	10·0
Rumput tadak embun .	21·1	2·4	35·7	25·3	15·5

The comparatively high protein content figures for *Panicum repens* and Rumput tadak embun and the low fibre content for *Digitaria longiflora* are noteworthy.

Nigeria.—According to Mr. J. K. Mayo, Senior Botanist, Northern Provinces, in his report for the half-year July to December 1939, the fodders normally used by stock owners in Northern Nigeria are the by-products of the crops grown for human food or for export, together with certain wild grasses and legumes which are cut and carried in from waste land. With a view to augmenting these supplies, the following are also under trial at Zaria and Kano: fodder canes from Barbados, sweet potatoes from Barbados and Sierra Leone, fodder sorghums from India, elephant grass from South Africa and the local variety (Napier grass).

FRUITS

Citrus

Dominica.—Mr. F. G. Harcourt, Agricultural Superintendent, has furnished a report on work carried out during the half-year ended June 30, 1940, from which the following particulars have been taken.

Lime Breeding.—The seedling hybrids mentioned in the last report (this BULLETIN, 1940, **38**, 187) have grown well and are to be budded or grafted before trial in the field. Recent pollinations will in most cases have to be repeated owing to failures during the drought.

Stock Trials for Limes.—During the early part of the dry season these trees yielded an unusually large number of green limes which is considered to be mainly due to sunny and dry weather which followed manuring in October. There was no appreciable difference in this early season crop between trees propagated on the various root-stocks.

Grapefruit and Orange Varieties.—In these trials an off-season crop was set, but development was retarded and no fruit is yet approaching maturity. The trees withstood the dry season fairly well with but few exceptions.

Government Fruit Farm.—Reference was made in an earlier report to experiments with lime and phosphates, of which soil analysis had indicated a marked general deficiency. Satisfactory growth increments as measured by the spread of the foliage in two directions have occurred for all trees and treatments, but whereas lime has in most cases produced the highest increases, those due to phosphates are less than in the control rows, except in one plot. The measurements were taken before and after three years' treatment of young trees, which are now just beginning to bear. All plots received good cultivation and vegetable mulches.

Tomatoes

Montserrat.—According to the report of Mr. W. E. Bassett, Curator, for the half-year ending June 30, 1940, ten new varieties of tomatoes were grown in a variety trial in 1940, but none of them showed any superiority over the variety usually grown for export from Montserrat, viz., "Marglobe." In tomato cultivation in Montserrat the plants are usually grown without stakes, and much of the fruit thus comes in contact with the ground. In an observational experiment the use of a mulch of dried grass seemed to decrease the proportion of fruit blemished from this cause.

Oil Seeds

Coconuts

Malaya.—Mr. F. C. Cooke, Chemist (Coconut Products), in his report for the half-year January to June 1940, states that investigations have been carried out with the new copra cabinets in order to ascertain the principal factors responsible for the variations in performance of the cabinets in different localities.

It has been shown that, as might be expected, the character of the coconuts under treatment is the principal factor. As regards the coconuts the controlling characteristics are (*a*) the original moisture content and texture of the undried meat, (*b*) the thickness of the undried meat, and (*c*) the diameter and thickness of the shells used as fuel. These characteristics, which profoundly affect the performance of the new kilns, vary from place to place according to the conditions under which the palms are growing.

Thus while the utility of these new and inexpensive kilns cannot be denied, it is unfortunately not possible to prescribe operating instructions to meet all conditions. The best method of operation must be determined for each set of conditions. The same naturally is true for all other types of copra kilns, any two of which are rarely if ever operated on the same plan, while irregularities of performance are masked by faulty production.

Ground-nuts

Nigeria.—Mr. J. K. Mayo, Senior Botanist, Northern Provinces, in his report for the half-year July to December 1939, states that selection work and variety trials with ground-nuts were being continued. There was trouble in 1939 from rosette disease in northern districts due to late planting and possibly wide spacing. It has been suggested that there is " deterioration " of ground-nuts in certain areas which can be remedied by introducing fresh seed from Kano and Zaria from time to time. Experiments to test this theory are to be started.

Oil Palms

Malaya.—Mr. Gunn Lay Teik, Acting Senior Chemist, in his report for the half-year January to June 1940, states that an experiment has been commenced in conjunction with an estate to select high yielding palms based on bunch weight and oil content of bunch, the ultimate object being to ascertain the weight of oil produced by individual palms over a definite period. So far the results indicate that bunches from palms with a high bunch weight record frequently contain a lower percentage of oil than normal.

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Annual Report on Working Plans, Silviculture and Entomology in Burma for the year 1938-39. Pp. 121, 9½ × 7¼. (Rangoon : Superintendent, Government Printing and Stationery, 1940.) Price Rs. 2.

Report of the Lands, Parks and Forests Branch, Department of Mines and Resources, Canada, for the year ending March 31, 1939. Pp. 167, 9¾ × 6½. (Ottawa : King's Printer, 1940.)

Report of the Department of Lands and Forests, Province of Nova Scotia, for 1939. Pp. 100, 9½ × 6½. (Halifax, N.S. : King's Printer, 1940.)

Annual Report on the Forestry Department, Gold Coast Colony, for the year 1938-39. Pp. 21, 13 × 8. (Accra : Publications Branch, Government Printing Department, 1939.) Price 2*s.*

Triennial Programme of Work for the Forest Research Institute, Dehra Dun, for 1939-42. Pp. 32, 9½ × 6. (New Delhi : Manager, Government of India Press, 1940.)

Quinquennial Review of the Forest Administration in Assam for the years 1934-35 to 1938-39 with the Progress Report for the year 1938-39. Pp. 133, 9½ × 6½. (Shillong : Government Press, 1939.) Price Rs. 2 As. 9.

Report of the Forest Department of the Madras Province for the year ending March 31, 1939. Vols. 1 and 2. Pp. 167, 9¾ × 6. (Madras : Government Press, 1939.)

Annual Administration Report of the Sind Forest Department, with Appendices, for the year 1938-39. Pp. 70, 9½ × 6¼. (Karachi : Sind Government Book Depot, 1939.) Price As. 7.

Report of Forest Administration in the United Provinces for the year 1938-39. Pp. 96, 9½ × 6. (Allahabad : Superintendent, Printing and Stationery, 1940.) Price As. 7.

Annual Report of the Forest Research Institute, Kepong, Forest Department, F.M.S. and S.S. Pp. 21, 13 × 8. (Kepong, Malaya : Forest Research Institute, 1940.)

Programme of Research for 1940 of the Forest Research Institute, Kepong, Forest Department, F.M.S. and S.S. Pp. 15, 13 × 8. (Kepong, Malaya : Forest Research Institute, 1940.)

Annual Report of the Forestry Department, Nyasaland, for the year 1939. Pp. 28, 13 × 8. (Zomba : Government Printer, 1940.) Price 1*s.*

Annual Report on the Forest Department, Trinidad and Tobago, for the year 1939. Pp. 16, 13 × 8½. (Trinidad : Government Printer, 1940.) Price 16 cents.

Timber

The Wood Anatomy of Some Australian Lauraceæ with Methods for their Identification. By H. E. Dadswell and A. M. Eckersley. *Bull. No.* 132, *Coun. Sci. Industr. Res. Aust.* Pp. 48 + 8 plates, 9½ × 6. (Melbourne : Government Printer, 1940.)

Air Drying Tests on Burma Timbers. A Record of Observations made during the period 1925-1936. By H. Barber. *Burma For. Bull. No.* 33. Pp. 70, 9½ × 6. (Rangoon : Superintendent, Government Printing and Stationery, 1940.) Price Rs. 2 As. 8.

The Chief Characteristics and Uses of Six New Guinea Timbers. By J. L. d'Espeissis. *New Guinea Agric. Gaz.*, 1940, **6**, No. 1, 65-68. Has reference to New Guinea walnut, erima, irotu, kwila, kamarere and toan.

Strength Tests of *Grewia elastica* Royle. By V. D. Limaye. *Indian For.*, 1940, **66**, 219-222.

Stains of Sapwood and Sapwood Products and their Control. By T. C. Scheffer and R. M. Lindgren. *Tech. Bull. No.* 714, *U.S. Dep. Agric.* Pp. 123, 9 × 6. (Washington, D.C. : Superintendent of Documents, Government Printing Office, 1940.) Price 20 cents.

Wood Wastes and their Utilisation. Some Aspects of a Complex Problem. By J. Grant. *Industr. Chem. Chem. Manuf.*, 1940, **16**, 169-176.

Gums and Resins

Trials with the Indian Lac Insect in Ceylon during 1938-39. By M. P. D. Pinto. *Trop. Agric., Ceylon*, 1940, **94**, 79-89.

Tanning Materials

Myrobalan Culture in Mysore. *Mysore Econ. J.*, 1940, **26**, 126-127.

IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 11

(April-June 1940)

Prepared in collaboration with the Imperial Institute of Entomology and the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

GENERAL

A Survey of Insecticide Materials of Vegetable Origin. Edited by H. J. Holman. (Imperial Institute, 1940.) Pp. vi + 155. A detailed account of the production and trade, botany, chemistry and insecticidal properties of the principal and lesser-known insecticides, with a bibliography of nearly 400 references.

The Chemistry and Toxicology of Insecticides. By H. H. Shepard. (Minneapolis, Minn.: Burgess Pub. Co., 1939.) Pp. iii + 383. (*R.A.E.*, 1940, **28**, A, Pt. 4, 147.) Over sixty pages are devoted to plant derivatives and related compounds, and numerous references are included.

Plant Insecticide Materials from Empire Sources. *Bull. Imp. Inst.*, 1940, **38**, No. 2, 150-163. Collected results of investigations carried out at the Imperial Institute during recent years on nicotine, derris, mundulea, tephrosia and pyrethrum samples.

Modern Insecticides. By W. E. Edmonton. *Soap, Perf. Cosmetics*, 1940, **13**, No. 6, 392-394. Chief applications of pyrethrum and derris in insect pest control.

Some Recent Contributions by English Workers to the Development of Methods of Insect Control. By C. T. Gimingham. *Ann. Appl. Biol.*, 1940, **27**, No. 2, 161-175. Derris and pyrethrum discussed, and bibliography included.

Insect Control Aloft. *Soap*, 1940, **16**, No. 6, 141. Note regarding spraying to control insects in airplanes.

Poisonous Plants of India. By R. N. Chopra and R. L. Badhwar. *Indian J. Agric. Sci.*, 1940, **10**, Pt. 1, 1-15. Besides such plants as derris, pyrethrum and tobacco, reference is made to a number of lesser-known insecticide plants and to others reputed to have insecticidal properties. Species of *Tephrosia, Delphinium, Veratrum* and *Picrasma* are included.

What is Moribund Kill? By R. B. Stoddard. *Soap*, 1939, **15**, No. 10, 93, 95, 97. (*R.A.E.*, 1940, **28**, B, Pt. 4, 79.)

Moribund Flies—Where do they figure in counting " Deads " under the Peet-Grady Procedure? Reports by A. Weed, L. D. Benedict and W. A. Simanton. *Soap*, 1940, **16**, No. 5, 98-103 and 117.

A Fundamental Error in the Peet-Grady Method. By C. A. Murray. *Soap*, 1940, **16**, No. 6, 111, 113, 115, 117, 119 and 125. The assumption of the method that individual flies receive similar doses of the test insecticide is proved to be invalid.

Presentation of Time-Dosage-Mortality Data by Three-dimensional Graphs. By R. Hansberry and S. F. Chiu. *J. Econ. Ent.*, 1940, **33**, No. 1, 139.

Biologische waardebepaling van ten bestrijding van schadelijke insecten gebezigde aanrakingsvergiften. (The biological evaluation of the contact poisons employed to combat insect pests.) By J. J. Fransen. *Landbouwk. Tijdschr.*, 1939, **51**, No. 624, 312-362. (*R.A.E.*, 1940, **28**, A, Pt. 3, 113-115.) Describes the results of tests using different concentrations of pyrethrum and derris dusts.

Insecticide Dispersion—a New Method of dispersing Pyrethrum and Rotenone in Air. By W. N. Sullivan, L. D. Goodhue and J. H. Fales. *Soap*, 1940, **16**, No. 6, 121, 123, 125.

Factors Influencing the Use of Some Common Insecticide-dispersing Agents. By L. H. Dawsey. *Circ. No.* 568 *U.S. Dep. Agric.*, 1940.

Stabilised Insecticide of Plant Origin. *U.S. Pat.* 2,090,109, Aug. 17, 1937. M. R. Coe (*Brit. Chem. Abstr.*, B, 1940, March, 235). Method of protecting powdered insecticides from deterioration by light.

Dusting Composition. *U.S. Pat.* 2,191,421, Feb. 20, 1940. *Rev. U.S. Pat. Pest Contr.*, 1940, **13**, No. 2, 6. Walnut shell flour used as a filler with rotenone and pyrethrum dusts.

Pests and Diseases in the Vegetable Garden. *Growmore Bul. No.* 2, *Ministr. Agric. Lond.*, 1940. Notes on uses of derris, pyrethrum and nicotine.

Twenty-fifth Annual Report, Experimental and Research Station, Cheshunt (1939), p. 40. Control of Vegetable Pests, Caterpillars. By E. R. Speyer, W. Read and O. Orchard. Derris and lonchocarpus effective against tomato and cabbage moth.

Twenty-fifth Annual Report, Experimental and Research Station, Cheshunt (1939), p. 40. Control of Vegetable Pests, Aphids. By E. R. Speyer, W. Read and O. Orchard. Good results from pyrethrum which proved more effective than 5 per cent. nicotine dust against *Macrosiphum gei*.

Spraying and Dusting to Control Insects and Diseases. *Tree Pest Leafl. Boston*, 1939, No. 31, pp. 4 (*Forestry Abstr. Oxford* 1940, **1**, No. 4, 295). Gives composition of various sprays containing derris, cube, nicotine and pyrethrum.

Control of the Japanese Beetle. By L. P. Johnson. *Circ. Conn. Agric. Exp. Sta.*, No. 132, 1939. Under certain conditions derris, cube or pyrethrum sprays are useful.

Specifications for Bedbug Liquid. *Soap*, 1940, **16**, No. 5, 115, 119.

ALKALOID-CONTAINING MATERIALS

Tobacco Products, including Nicotine and Nicotine Derivatives

Export Trade in and By-products Uses of Tobacco. Letter from Secretary of Agriculture. U.S. Senate, 76th Congress (1st Session), Document No. 39, 1939. Contains an account of the insecticidal uses of nicotine in different forms and gives U.S. exports of nicotine sulphate.

Agricultural Insecticides Imported into New Zealand. Use of Nicotine in Various Forms. *World Tr. Notes, U.S. Dep. Comm.*, 1940, **14**, No. 1, 4.

Nicotine and Compounds under Insecticides and Fungicides Poison Regulations in Germany. *World Tr. Notes, U.S. Dep. Comm.*, 1940, **14**, No. 15, 227.

Nicotine Exports from France Prohibited. *World Tr. Notes. U.S. Dep, Comm.*, 1940, **14**, No. 16, 246.

Tobacco Alkaloids. XVI, *l*-Methylpyrrolidine, a New Tobacco Alkaloid. Constitution of *iso*Nicoteine. By E. Spath and S. Biniecki. *Ber. Dtsch. Chem. Ges.*, 1939, **72**, B, 1809-1815.

Rearing Mosquito Larvæ and Effect of Diet on their Resistance to Rotenone and Nicotine. By A. M. Phillips and M. C. Swingle. *J. Econ. Ent.*, 1940, **33**, No. 1, 172-176.

Control Experiments on the Tomato Fruitworm in Southern California during 1937. By J. Wilcox and M. W. Stone. *J. Econ. Ent.*, 1940, **33**, No. 1, 129-133. Materials tested include nicotine and cube.

Whats New in Farm Science. Annual Report of the Agricultural Experiment Station, University of Wisconsin, Madison. *Bulletin No.* 449, 1940, Part 2, p. 56. Derris-nicotine dust described as being effective in controlling cabbage worm and cabbage aphid.

The Control of Lettuce Aphis. By D. W. Wright. *Fruit-grower*, 1939. **88**, No. 2291, 539-540. (*R.A.E.*, 1940, **28**, A, Pt. 6, 299.) Treatments recommended include dipping the plants in nicotine wash, or dusting or spraying with nicotine preparations.

Pea Aphid Control in Oregon. By K. W. Gray and J. Schuh. *J. Econ. Ent.*, 1940, **33**, No. 1, 72-77. Tests with nicotine and rotenone.

Experiments with Insecticides in the Control of the Sugarcane Borer, *Diatraea saccharalis* Fab. By L. O. Ellisor and J. W. Ingram. *Proc. Int. Soc. Sug. Cane Tech.*, 1939, **6**, 693-705. (*R.A.E.*, 1940, **28**, A, Pt. 5, 254.) Dual-fixed nicotine proved ineffective.

Other Alkaloid-containing Materials

Alkaloids of White Hellebore. IV, Veratramine, a New Alkaloid of White Hellebore (*Veratrum grandiflorum* Loes. fil.). By K. Saito. *Bull. Chem. Soc. Japan*, 1940, **15**, 22-27 (*Brit. Chem. Abstr.*, 1940, May, A, II, 198).

INSECTICIDE MATERIALS CONTAINING ROTENONE AND ALLIED SUBSTANCES

General

Le Piante insetticide rotenoniche, Part 1. (Insecticidal plants yielding rotenone.) *Riv. Ital. Essenze*, 1940, **22**, 117-121. Discusses constituents, and evaluation and marketing of rotenone.

Rotenone Determination. By T. M. Meijer and D. R. Koolhaas. *Ind. Engng. Chem., Anal. Ed.*, 1940, **12**, 205-209. Details of a method of analysis of derris and cube root.

Determination of Rotenone in Derris and Cube Powders: Use of Decolorising Carbon in the Chloroform Extraction Method. By J. J. T. Graham. *J. Assoc. Off. Agric. Chem.*, 1939, **22**, No. 2, 408-411. (Abstract in *Exp. Sta. Rec.*, 1940, **82**, No. 4, 439.)

Crystalline Solvates of Inactive Deguelin. By L. D. Goodhue and H. L. Haller. *J. Amer. Chem. Soc.*, 1939, **61**, No. 2, 486-488.

Composition and Length of Action of Rotenone Powders. By J. Feytaud and P. de Lapparent. *C. R. Acad. Agric. France* 1939, **25**, 1039-1044. (Abstract in *Soap*, 1940, **16**, No. 6, 131, and *Amer. Chem. Abstr.* 1940, **34**, No. 8, 2521.) Mixtures containing 15 per cent. derris or cube root were found practically as effective as the pure undiluted powders.

L'appréciation de la valeur insecticide des plantes roténonées d'après le dosage de la roténone. By A. Guillaume and G. Hervé. *Rev. Bot. Appl.*, 1939, **19**, No. 216, 552-564. (*R.A.E.*, 1940, **28**, A, Pt. 4, 208.)

Pea Aphid Control in Oregon. By K. W. Gray and J. Schuh. *J. Econ. Ent.*, 1940, **33**, No. 1, 72-77. Tests with rotenone and nicotine.

Suggestions for Control of Pea Weevils in Oregon. *Station Circ.* 126, *Oregon State College* (Brief note in *Soap*, 1940, **16**, No. 6, 139). Rotenone dust found highly effective.

Derris

Report of the Department of Agriculture, Mauritius, for 1938, pp. 49, 56. Experimental cultivation of derris, yield, rotenone content and toxicity of the root.

Derris or Tuba Root. A Note on Yield and Cost of Production in East Africa. *E. Afr. Agr. J.*, 1940, **5**, No. 5, 362-363.

Further Experiments with Selected Plants of *Derris elliptica*, Changi No. 3. By C. D. V. Georgi and Gun Lay Teik. *Malay. Agric. J.*, 1940, **28**, No. 2, 44-68. Concerned with yield of root, ether extract and rotenone content of vegetative progeny of selected plants.

Table of Exports of Derris Root from British Malaya, 1934-1939. *World Tr. Notes, U.S. Dep. Comm.*, 1940, **14**, No. 20, 315.

Result of Analysis of Derris Roots at the Coast Experimental Station, Kilifi, Kenya. *E. Afr. and Rhod.*, 1940, **16**, No. 817, 742.

The Active Principles of Leguminous Fish-poison Plants. Part IV. The Isolation of Malaccol from *Derris malaccensis*. By S. H. Harper. *J. Chem. Soc.*, 1940, March, 309-314.

The Problem of the Evaluation of Rotenone-containing Plants: V, The Relative Toxicities of Different Species of Derris. By J. T. Martin. *Ann. Appl. Biol.*, 1940, **27**, No. 2, 274-294.

De waardebepaling van derris door entomologische onderzoek. (The evaluation of derris by tests on insects.) By J. van der Vecht. *Versl.* 25 *Vergad. Vereen. Proefst. Pers., Oct.*, 1937 (1938) 197-214. A review of the literature.

In hoeverre mogen kalkhoudende draagstoffen in een Derrisstuifmengsel gebruikt worden ? (To what extent can lime carriers be used in derris dust mixtures ?) *Ind. Mercuur*, 1940, **63**, No. 15, 149-150. (*Ber. Afd. Handelsmus. Kon. Ver. Kol. Inst.*, No. 146.)

Toxicants and Solids added to Spray Oil in Control of California Red Scale. By W. Ebeling. *J. Econ. Ent.*, 1940, **33**, No. 1, 92. Derris resin incorporated with oil; walnut-shell flour combined with oil-toxicant.

Rearing Mosquito Larvæ and Effect of Diet on their Resistance to Rotenone and Nicotine. By A. M. Phillips and M. C. Swingle. *J. Econ. Ent.*, 1940, **33**, No. 1, 172-176.

Contributions on Economic Entomology. The Action of Derris on Bees. By F. K. Böttcher. *Ztschr. Angew. Ent.*, 1938, **25**, No. 4, 681-702. (Noted in *Exp. Sta. Rec.*, 1940, **82**, No. 3, 354.)

Control of Coconut Treehoppers (*Sexaua* spp.) by Dusting. By B. A. O'Connor. *New Guinea Agric. Gaz.*, 1940, **6**, No. 1, 38-43. Derris dusts tested.

What's New in Farm Science. Annual Report of the Agricultural Experiment Station, University of Wisconsin, Madison. *Bulletin No.* 449, 1940, Part 2, p. 56. Derris-nicotine dust described as being effective in controlling cabbage worm and cabbage aphid.

The Control of Sheep Ticks. By W. L. Stewart and A. P. Ponsford. *Vet. Rec.*, 1939, **51**, 1481-1485. The use of derris dust was found to be more effective than dipping solutions.

The Economic Importance of *Ixodes ricinus*. By W. L. Stewart. *Vet. J.*, 1939, **95**, 341-349. Protection of sheep and lambs is described, by applications of derris in the form of dips, dusts and smears.

Über die bei der amtlichen Dasselbekämpfung 1936/37 in Kreise Hannover-Land gemachten Erfahrungen. (The 1936/37 Official Campaign against Ox-Warble Flies in the district of Hannover.) By H. Wiebringhaus. *Mang. Diss., Hannover*, 1937 (Abstract in *Vet. Bull. Weybridge*, 1940, **10**, No. 4, 257-8). Use of derris preparations.

Die Verordnung zur Durchführung und Ergänzung des Gesetzes zur Bekämpfung der Dasselfliege vom 19.4.1937 und die Durchführung des Dasselgesetzes im Regierungsbezirk Schleswig in 1937. (Germany: Order on the carrying out of the law for the control of warble flies, April 19, 1937, and warble fly control in Schleswig in 1937.) By Bartels. *Berl. Tierärztl. Wschr.*, 1938, March 25, 169-171. (Abstract in *Vet. Bull. Weybridge*, 1940, **10**, No. 4, 258.) Application of derris.

Dasselbekämpfungsversuche in Bayern, 1938. (Control of ox warbles in Bavaria in 1938.) By J. Spann and L. Pedretti. *Berl. Münch. Tierärztl. Wschr.*, 1938, Nov. 4, 669-674. (Abstract in *Vet. Bull. Weybridge*, 1940, **10**, No. 4, 258.) Experiments with derris washes and with the injection of derris preparations into the warbles.

Zur Bekämpfung der Dasselplage 1937 in Oberbayern und im Allgau (Ganzbehandlungsversuche am Hohenvieh). (Ox warble control in Upper Bavaria and Allgau in 1937.) By L. Pedretti. *Münch. Tierärztl. Wschr.* 1938, **89**, 26-33. (Abstract in *Vet. Bull., Weybridge*, 1940, **10**, No. 4, 258.) Different commercial derris preparations tested.

Toxicity of Derris Root to the Snail Hosts of the Bilharzia Parasite. *E. Afr. and Rhod.*, 1940, **16**, No. 812, 651.

Lonchocarpus

Report of the Puerto Rico Experiment Station, U.S. Dept. Agric., Nov. 1939, pp. 55-58. Notes on investigations on lonchocarpus cultivation.

Control Experiments on the Tomato Fruitworm in Southern California during 1937. By J. Wilcox and M. W. Stone. *J. Econ. Ent.*, 1940, **33**, No. 1, 129-133. Materials tested include nicotine and cube.

Arsenical Insecticides unsatisfactory in Peru. *Oil, Paint, Drug Rep.* 1940, **137**, No. 14, 35, and *World Tr. Notes, U.S. Dep. Comm.*, 1940, **14**, No. 11, 174. Damage from "melaza" residue on cotton leaves due to treatment for leafworm with arsenicals. Use of cube dust mixed with finely ground sulphur recommended.

Others

The Insecticidal Properties of Certain Species of *Annona* and of an Indian Strain of *Mundulea sericea* ("Supli"). By F. Tattersfield and C. Potter. *Ann. Appl. Biol.*, 1940, **27**, No. 2, 262-273.

PYRETHRIN-CONTAINING MATERIALS

Pyrethrum. A Potential Industry for South Africa? By R. A. Dyer. *Fmg. S. Afr.*, 1940, **15**, No. 170, 183-186. An illustrated account of cultivation, harvesting and drying.

Pyrethrum Breeding. By H. C. Thorpe. *E. Afr. Agric. J.*, 1940, **5**, No. 5, 364-368 and No. 6, 479-480.

Notes on Pyrethrum Driers. By Gilbert Walker. *E. Afr. Agric. J.*, 1940, **5**, No. 6, 466-469.

Annual Report for 1938-39, Imperial Council of Agricultural Research, India (1939), p. 41. Cultivation of pyrethrum in India. Progress report.

Experimental Cultivation of Pyrethrum in India. *Capital* (India), 1939, March, 481.

Pyrethrum Seed Supplies for Experimental Propagation Under Different Climatic Conditions in the Punjab and Kashmir. *Indian Tr. J.*, 1939, **135**, No. 1748, 1003.

L'Agriculture du Congo Belge en 1938. *Bull. Agric. Congo Belge*, 1939, **30**, No. 4, 555. Provincial report on cultivation of pyrethrum in Costermansville.

Le Pyrèthre—Culture et Utilisation. Propagande et Vulgarisation agricoles. *Ministr. Colon., Direct. Gén. Agric. Élev., Bruxelles Ser. A: Phytotec. Tract No.* 1. (*Plant Breed. Abstr.*, 1940, **10**, No. 2, 153.)

Experiments in the Cultivation of Pyrethrum in Peru, to Develop Production on a Commercial Scale. *World Tr. Notes, U.S. Dep. Comm.*, 1940, **14**, No. 19, 302.

Mechanical Harvester for Pyrethrum Flowers developed by the United States Department of Agriculture. *Oil, Paint, Drug. Rep.*, 1940, **137**, No. 18, 3, and brief note in *Soap*, 1940, **16**, No. 6, 133.

Countries Producing Pyrethrum Flowers for Export. *Foreign Crops and Markets, U.S. Dep. Agric.*, 1940, **40**, No. 7, 198.

Pyrethrum Imports into United States, 1937-1939. *World Tr. Notes, U.S. Dep. Comm.*, 1940, **14**, No. 16, 246.

Yugoslavia Pyrethrum Crop for 1939 reported Sold. *World Tr. Notes, U.S. Dep. Comm.*, 1940, **14**, No. 18, 284. Whole of the 1939 crop of about 950 tons sold to local exporters.

Insect Powder Labels. *Soap*, 1940, **16**, No. 4, 97, 99, 101, 115. Questions of labelling in relation to different grades and deterioration.

Determination of Pyrethrin: 1, Investigation of Seil Colour Reaction in Mercury Reduction Method. By C. S. Sherman and R. Herzog. *Ind. Engng. Chem., Anal. Ed.*, 1940, **12**, No. 3, 136-137.

A Direct Oxidase present in *Pyrethrum cinerariaefolium*. By Mario Covello. *Ann. Chim. Applicata*, 1939, **29**, 333-339. (*Amer. Chem. Abstr.*, 1940, **34**, No. 3, 781.)

The Chemical Control of Insect Pests of Animals. By J. Hendrick and W. Moore. *Trans. Highl. Agric. Soc. Scot.*, 1939, **51**, 58-74. Describes sprays and smears containing pyrethrins.

A Brief History of Household Insect Sprays. By I. P. MacNair. *Soap*, 1940, **16**, No. 6, 104-107. Pyrethrum in sprays.

A New Fly Spray. *Agric. News Letter (Du Pont)*, 1940, **8**, No. 2, 38. Value of a castor oil derivative (isobutyl undecylenamide) in admixture with pyrethrum as a fly spray.

Federated Malay States—Annual Rept. Inst. Medical Research for 1938 (1939), p. 5. Reference to tests with addition of pyrethrum to oils used as mosquito larvicides. More rapid kill obtained but final mortality remained unaltered.

Twenty-fifth Annual Report, Experimental and Research Station, Cheshunt (1939), p. 42. Control of Vegetable Pests—Mushroom Pests. By E. R. Speyer, W. Read and O. Orchard. Sciarid flies controlled by pyrethrum.

Twenty-fifth Annual Report, Experimental and Research Station, Cheshunt (1939), p. 43. Control of Vegetable Pests—Thrips. By E. R. Speyer, W. Read and O. Orchard. Pyrethrum as a control measure.

Laboratory Tests with Liquid Insecticides on the Eggs of the Bed-bug, *Cimex lectularius* L. By S. Callaway and A. J. Musgrave. *Ann. Appl. Biol.*, 1940, **27**, No. 2, 252-261. Materials tested include pyrethrins.

The Use of Insecticides in Light Mineral Oil for Corn Ear Worm Control. By G. W. Barber. *J. Econ. Ent.*, 1939, **32**, No. 4, 598. (*R.A.E.*, 1940, **28**, A, Pt. 4, 184.) Addition of pyrethrins increased effectiveness of the oil.

Experiments with Pyrethrum for the Control of Codling Moth (*Carpocapsa pomonella* L.). By C. B. Gnadinger, J. B. Moore and R. W. Coulter. *J. Econ. Ent.*, 1940, **33**, No. 1, 143-153.

Toxicity of Pyrethrum Insecticides to Codling Moth. *E. Afr. and Rhod.*, 1940, **16**, No. 816, 726.

Control of the Sugar Cane Froghopper by the Use of Pyrethrum Dust. By A. Pickles. *Proc. Agric. Soc. Trin. Tob.*, 1940, **40**, Pt. 1, 57-61.

OTHER INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

Waarnemingen over de insecticide-werking van het Surinaamsche kwassiehout *Quassia amara* L. (Observations on the insecticidal action of

Surinam quassia wood, *Quassia amara* L. *Ind. Mercuur*, 1940, **63**, No. 14, 138-139.)

The Insecticidal Properties of Certain Species of *Annona* and of an Indian Strain of *Mundulea sericea* ("Supli"). By F. Tattersfield and C. Potter. *Ann. Appl. Biol.*, 1940, **27**, No. 2, 262-273.

The Constituents of Certain Species of Helenium: III, The Ester Nature of Tenulin. By E. P. Clark. *J. Amer. Chem. Soc.*, 1940, **62**, No. 3,597-600.

Toxicity of the Fruits of *Sapindus saponaria* to the Snail Hosts of the Bilharzia Parasite. *E. Afr. and Rhod.*, 1940, **16**, No. 812, 651.

NOTE.—In No. 10 of this Bibliography, under the section on Pyrethrin-Containing Materials, reference was made to a note on Kenyan export prohibitions published in the *Chem. Tr. J.*, 1939, **105**, No. 2741, 430, in which it was stated that the export of pyrethrum to foreign countries is prohibited. Reference to the original Government Notice shows that this should read: "Export of pyrethrum to foreign countries prohibited except under license." In fact, most of the Kenya pyrethrum is still exported to the U.S.A.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

SOILLESS CULTURE SIMPLIFIED. By Alex Laurie. Pp. xiii+201, 8 × 5½. (London: McGraw-Hill Publishing Co., Ltd., 1940.) Price 12*s*. 6*d*.

So many misleading and wildly exaggerated claims have been made for the possibilities of this "new discovery"—soilless culture—that it is refreshing to find a book dealing with the subject in its proper perspective. The author is performing a definite service to the public in dispelling some of the false impressions that have been so widely spread, and it is of particular interest that he goes into the early history of water culture, showing that far from being a new discovery, the technique was known nearly a century ago.

Apart from its merits in this direction the book contains a good practical account of plant nutrition, with a brief chapter on the fundamentals of plant physiology, which will be useful in giving the layman a more thorough understanding of the problems discussed. The detail with which nutrient deficiency symptoms of a number of common horticultural crops are described makes this section of value to a wider circle than those concerned purely with soilless culture.

In the remainder of the text, which comprises a little more than half the book, the technique and practice of soilless culture and the equipment required are described, both from the standpoint of the commercial producer and of the amateur. Separate chapters are devoted to accounts of technique when sand and gravel are used as inert media.

There are a number of useful photographs and diagrams in the text, and a short index concludes the book.

THE MINOR ELEMENTS OF THE SOIL. Imperial Bureau of Soil Science, Technical Communication No. 39. Pp. 86, $9\frac{3}{4} \times 7\frac{1}{2}$. (Harpenden, England: Imperial Bureau of Soil Science, 1940.) Price 4*s*.

Though "The Minor Elements of the Soil" is essentially a revision of *Technical Communication No.* 31, "Soil Deficiencies and Plant Diseases," published in 1934, many of the sections have been completely rewritten in bringing the text up to date, and the scope has been widened by the consideration of six further elements.

In addition to the elements associated with plant disorders, whether as a result of deficiency or excess in the soil, those affecting grazing animals are also included. The list comprises boron, manganese, copper, zinc, iron, magnesium, sulphur, iodine, cobalt, selenium, molybdenum, thallium and chromium. Each element is dealt with in a separate section, taking the form of a digest of the information available and a detailed list of references to literature. Crop and stock disorders associated with each are discussed.

The value of the publication in collecting together this body of information which is so widely scattered through the literature must be apparent. It seems, however, a pity that there is no general section, surveying the field as a whole and correlating some of the information and theories that have been put forward regarding individual elements.

THE CHEMICAL CONSTITUTION OF NATURAL FATS. By T. P. Hilditch, D.Sc., F.I.C. Pp. xi + 438, $9\frac{3}{4} \times 6$. (London: Chapman and Hall, Ltd., 1940.) Price 35*s*.

Most books hitherto published on fats have been more concerned with the occurrence, uses and analytical data of these materials than with their chemical constitution. This in the main has been due to the incompleteness of the knowledge of their chemical constitution. However, during the past twenty years, a considerable amount of research work has been carried out on this aspect of the subject by many investigators, among whom the author and his collaborators occupy a prominent place.

In this book the results of these investigations are assembled with a view to giving as complete an account as possible of the constitution of natural fats, and more especially the glycerides which are produced naturally in plant and animal life. The fats are treated herein as a group of organic chemical compounds in the same way as it has been found helpful to have separate monographs dealing with other natural groups such as the carbohydrates, terpenes, etc. From this mode of presentation of the subject it follows that fats are not primarily considered either from the standpoint of their utility as raw materials for any industrial purpose or with regard to their biochemical functions in the organisms in which they are produced.

The first chapter is mainly devoted to a survey of the data discussed in fuller detail in the next six chapters, in which are

described the component acids of fats of aquatic flora and fauna; of fats of land animals and of vegetable fats; and the component glycerides of vegetable and animal fats. Chapter VIII is ancillary and deals with some aspects of the biochemistry of fats. Then follows a section on the constitution of individual natural fatty acids. A brief account of the main advances in the study of synthetic glycerides and the natural occurrence of higher aliphatic alcohols and of glyceryl ethers is given in Chapter X. The final chapter is of particular interest to the research worker and describes the methods employed by the author and his collaborators in the quantitative investigation of the constitution of fats and supplies in detail the technique used. The book closes with a general index and indexes of individual fats and waxes and of individual fatty acids and glycerides.

This volume is of outstanding merit and furnishes comprehensive information on an aspect of fats which has been unfortunately neglected for so many years. It will be of great value to those engaged in the examination of fats and to others employed in industries of which fats form one of the chief raw materials. The collection in one book of the results of the investigations of many workers fulfils a long-felt need.

THE SCIENTIFIC PRINCIPLES OF PLANT PROTECTION. By Hubert Martin, D.Sc., A.R.C.S., F.I.C. Third Edition. Pp. x + 385, 8½ × 5½. (London: Edward Arnold & Co., 1940.) Price 22*s.* 6*d.*

Notices of the previous editions of Dr. Martin's book have appeared in this BULLETIN, 1929, **27**, 263, and 1936, **34**, 548. A new edition of this most useful work is of particular value in view of the considerable advances that have been made in our knowledge of the subject during the four years since the appearance of the second edition.

The general plan followed remains unaltered, but the text has been revised and brought up to date with corresponding additions to the book references. The addition of new matter has been accompanied by a " drastic pruning of the text," which as a result is scarcely any longer than in the second edition. The principal additions are in the accounts of virus diseases, epidemiological factors determining the degree of attack and the application of laboratory research in the assessment of efficiency of insecticides and fungicides.

APPLIED MYCOLOGY AND BACTERIOLOGY. By L. D. Galloway, M.A., and R. Burgess, M.Sc., Ph.D. Pp. viii + 186, 8½ × 5½. (London: Leonard Hill, Ltd., 1940.) Price 10*s.*

This book, first published in 1937, has proved its merits by appearing now in a second printing, in which the opportunity has been taken to revise the text and references and to add to the illustrations.

While of undoubted value to a wide range of scientific workers,

it is to the industrial chemist confronted with practical problems in microbiology that the book should prove most useful. Without assuming a biological training on the part of the reader, the authors give a concise description of the apparatus and technique for the isolation, culture and staining of micro-organisms, with chapters also on the general nature of fungi and bacteria, their metabolism and the methods of controlling them. This forms the first part of the book, the second being devoted to an account of the industrial applications of microbiology. This includes discussions on the spoilage and preservation of foods, industrial fermentation processes, the bacterial retting of textile fibres, micro-organisms pathogenic to man and animals, and finally agricultural and miscellaneous applications of microbiology.

The treatment of so wide a field within a single volume must necessarily be somewhat in the nature of a survey, but the main outlines are clearly given, and numerous references included at the end of each chapter act as a guide for further detailed study.

A REVIEW OF DRIERS AND DRYING. By E. F. Bennett. Pp. 106, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: *Paint Technology*, 1940.) Price 3*s*. 6*d*.

This volume consists of a reprint in book form of a series of articles by the author which appeared in *Paint Technology* during April to September 1939. To these articles forewords have been added by Dr. J. S. Long and Dr. W. Krumbhaar. The contents include a compilation of the information on drying oils, the fundamental principles of the drying phenomenon and the influence of driers thereon, and are derived from the results of work conducted during many years by investigators throughout the world.

The introductory chapter is devoted to a consideration of the drying oils and their constitution; the general principles of drying and the use of driers to assist the process; and the changes that take place. The next chapter deals in greater detail with oxidation; the mechanism of oxygen addition; the formation and action of peroxides and other products of oxidation; polymerisation and the function and action of the polymerides formed; and the types of volatile substances produced during drying.

Film structure forms the subject of the third chapter. In the following chapter the various types of driers are described and their relative efficiencies discussed together with the properties imparted by the metallic portion thereof. Chapter V deals with the constitution of varnishes; the effect of the resin constituents and the influence of different solvents. Other sections of this chapter are devoted to skinning and its prevention, and to antioxidants. The last chapter describes the influence of pigments on paints in both the liquid state and the dried film. Author and subject indexes then follow.

The book deals with the subject in a concise manner and should be of use to those engaged in the paint and varnish industries.

MINERAL RESOURCES

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Indian and Colonial Governments

PURIFICATION OF QUARTZ SAND FROM CEYLON FOR GLASS-MAKING PURPOSES

THE Government of Ceylon, through its various technical departments, takes a considerable interest in the development of existing local industries, and in the possibility of establishing others in cases where the necessary raw materials may be available. The Imperial Institute has recently been able to give assistance in connection with a project to manufacture Portland cement in the Colony, and has examined and made reports on a number of clays, limestones, coral, etc. The local salt industry has also been given help, and an account of an investigation carried out for the Salt Adviser appeared in this BULLETIN, 1938, **36**, 326-334.

The possibility of manufacturing glass from the large local deposits of silica sand which are readily accessible has often been considered, but samples of this sand which were examined at the Institute in 1918 were found to be suitable only for the manufacture of inferior grades of glassware, on account of their high iron oxide content and coarseness of grain.

A further sample of sand was recently sent to the Institute for examination in order to determine whether these defects could be economically overcome, and the sand thereby rendered fit for the manufacture of glassware of medium quality. It has been found possible, by a combination of sieving and electro-magnetic separation, to prepare a glass sand of high purity from the sample, and an account of the procedure adopted, which is published by courtesy of the Department of Mineralogy, Ceylon, may be of interest.

Microscopical and Chemical Examination of the Sand

When examined under the microscope the sand was seen to consist chiefly of sub-angular to rounded grains of quartz, varying in size from less than 0·05 mm. up to about 3 mm. in diameter. There was very little fine mineral dust and no clayey matter, and

the quartz grains were free from surface iron-staining. About 1 per cent. of ilmenite was present in the form of small rounded grains, together with a small quantity of magnetic garnet. Measurement of the ilmenite grains with an eye-piece micrometer showed that the great majority were less than 0·2 mm. in diameter. The remainder were nearly all between 0·2 and 0·4 mm., and only a very occasional grain was noted of greater diameter than 0·4 mm. The average grain-size of the ilmenite was thus very considerably less than that of the quartz. The amount of iron in the sand was found to be 0·36 per cent., calculated as ferric oxide (Fe_2O_3), and was derived chiefly from the ilmenite. This amount is much in excess of that permissible in glass-sand of good quality.

The grading of a glass-sand is of the utmost importance, since uniformity of grain-size and freedom from extremes of coarse or fine material are very desirable qualities in ensuring rapidity and evenness of melting. It is stated that the well-known glass-sand of Fontainebleau (France) contains 80 per cent. of grains between 0·254 and 0·157 mm. in diameter, and that of King's Lynn (England) 78 per cent. between the same limits. Boswell, in his Memoir on British Resources of Sands and Rocks used in Glass-making, London, 1918, states that glass-sand should have over 70 per cent., and preferably over 90 per cent., of one grade, the best grade being that of medium grain-size (0·25—0·5 mm. diameter).

A representative sample of the Ceylon sand was subjected to a sieving analysis, with the following results:

	Per cent.
Retained on B.S. sieve No. 7, aperture 2·411 mm.	trace
Passing „ „ No. 7, „ „ „ Retained on „ „ No. 10, „ 1·676 „	0·1
Passing „ „ No. 10, „ „ „ Retained on „ „ No. 14, „ 1·204 „	0·6
Passing „ „ No. 14, „ „ „ Retained on „ „ No. 18, „ 0·853 „	2·4
Passing „ „ No. 18, „ „ „ Retained on „ „ No. 25, „ 0·599 „	6·5
Passing „ „ No. 25, „ „ „ Retained on „ „ No. 36, „ 0·422 „	18·0
Passing „ „ No. 36, „ „ „ Retained on „ „ No. 52, „ 0·295 „	33·3
Passing „ „ No. 52, „ „ „ Retained on „ „ No. 72, „ 0·211 „	20·8
Passing „ „ No. 72, „ „ „ Retained on „ „ No. 100, „ 0·152 „	10·8
Passing „ „ No. 100, „ „ „ Retained on „ „ No. 150, „ 0·104 „	5·8
Passing „ „ No. 150, „ „ „ Retained on „ „ No. 300, „ 0·053 „	1·5
Passing „ „ No. 300, „ „ „	0·2
Total	100·0

It will be seen from these results that about 83 per cent. of the grains of the Ceylon sand lie between 0·152 mm. and 0·599 mm. in diameter. The sand is therefore mainly a mixture of fine, medium and coarse grades, and, in spite of comparative freedom from extreme fractions, must be regarded as badly graded in comparison with well-known glass-sands.

Purification Tests

It was clear, from the results of the examination, that it would not be practicable to utilise the entire sand for glass manufacture, and that an endeavour must be made to separate from it, by a simple procedure, and with as little waste as possible, a glass-sand of satisfactory grain-size and iron content.

Accordingly, a representative sample of the sand was divided into three fractions by means of two standard sieves. These fractions were examined with the following results:

Fraction.	Grade.	Percentage of entire sample.	Ferric oxide (Fe_2O_3). *Per cent.*	Remarks.
A	Retained on B.S. sieve No. 36 (aperture 0·422 mm.)	25·3	0·05	Coarse grains, from 0·42 mm. up to 3 mm. Very occasional grain of ilmenite present.
B	Passing B.S. sieve No. 36 and retained on B.S. sieve No. 72 (aperture 0·211 mm.)	54·0	0·08	Occasional grains of ilmenite present.
C	Passing B.S. sieve No. 72	20·5	1·40	About 3 per cent. of ilmenite present.
	Total	99·8		

The percentage results obtained with the two sieves used in this test approximate closely to the corresponding totals of the results shown in the previous complete sieving test.

It will be seen from these figures that over 80 per cent. of the total iron is contained in the fine fraction C. The remainder is divided fairly evenly between the other two fractions, and is present mainly as ilmenite, with some magnetic (ferruginous) garnet.

Fraction A could not be used for glass-making without grinding and grading. Treatment to remove particles of iron derived from the grinding machinery would also be necessary and would add to the cost. As this fraction constitutes only about 25 per cent. of the sand it would probably be more economical to reject it.

Fraction B represents a well-graded sand of fair quality which would probably be suitable for the manufacture of colourless bottles and common tableware, sheet-glass, etc.

It was found that a sand of high quality could be easily obtained from this fraction, since the few grains of ilmenite and garnet which are contained in it were completely removable by electromagnetic

means. This treatment yielded a product containing only 0·01 per cent. of ferric oxide (Fe_2O_3). The purified material, which constitutes more than 50 per cent. of the whole sand, compares favourably in respect of its iron content with the best glass-sands of commerce, and should be suitable for the manufacture of such special products as optical glass and high-grade crystal.

Fraction C could be rejected, or used without further treatment for the manufacture of dark-coloured glass, if such a product were required.

Summary

The sample as received represents a badly-graded sand, unsuitable in its natural state for the manufacture of medium-quality glassware on account of its irregular grain-size and high iron content. The latter defect is due principally to the presence of fine grains of ilmenite.

Screening through two sieves of appropriate size gives a middle fraction consisting of more than one-half of the original sand and effects a considerable concentration of ilmenite in the finest fraction. The product represents well-graded sand of satisfactory iron content, suitable for the manufacture of medium-quality glassware.

Electromagnetic treatment of this middle fraction yields a sand of great purity, suitable for the manufacture of special glasses of high quality.

PROGRESS IN COLONIAL MINERAL INDUSTRY

Comprising periodic statements on mining and geological activities received from Government Technical Departments overseas.

BRUNEI

According to information supplied by the British Resident, the production of oil in the first quarter of 1940 amounted to 200,576·35 tons. This represents the net production, after deducting water run off and pumping losses between field and refinery.

KENYA

The following report has been received from the Commissioner of Mines.

Mineral Production.—Refined gold produced during the year 1939 amounted to 77,444 oz., valued at £607,753 18*s.* 2*d.*, as compared with 69,000 oz., valued at approximately £500,000 during the year 1938. One producing company increased its monthly production by approximately 1,000 oz. per month.

In addition to gold, refined silver valued at £1,158, and soda ash, etc., to the value of £186,000 was produced during the year.

The total value of minerals exported during the year was approximately £795,635.

MONTHLY PRODUCTION OF GOLD, 1939

Month.	Refined Gold. (Troy oz.)	Value. £	s.	d.
January	6,026	44,718	12	10
February	5,889	43,686	10	7
March	6,097	45,277	7	1
April	6,058	44,986	9	5
May	6,471	48,033	10	5
June	5,855	43,546	14	4
July	6,001	44,582	18	8
August	6,384	52,819	7	4
September	6,215	52,138	7	11
October	6,238	52,400	2	8
November	8,675	72,875	19	11
December	6,647	55,834	9	3
Supplementary return	888	6,853	7	9
Total	77,444	£607,753	18	2

MONTHLY PRODUCTION OF GOLD, 1940

Month.	Refined Gold. (Troy oz.)	Value. £	s.	d.
January	6,665	55,550	0	9
February	6,472	54,438	5	6
March	6,544	54,997	11	5
Total	19,681	£164,985	17	8

Magnesite.—A Company registered as Kenya Magnesite, Ltd., has recently been formed to operate a deposit of magnesite in the Mtito Andei area of the Colony. It is understood that a trial consignment of 500 tons will be exported to England in July.

Colonial Development Fund.—A free grant of £30,000 under the Colonial Development Fund for geological and mineral survey of selected areas in the Colony was approved in July, 1939. With the outbreak of war the scheme was suspended. Early in 1940, however, a modified scheme considered more suitable for war-time conditions, and estimated to cost £15,000, was submitted and approved. The staff to carry out this modified scheme has been recruited and work commenced.

MALAY STATES (FEDERATED)

The following data for the first quarter of 1940 have been compiled from returns furnished by the Chief Inspector of Mines.

PRODUCTION OF TIN-ORE
(January to March 1940)

State.	Metal content. (Long tons.)	Value. (£.)
Perak	11,998	2,906,829
Selangor	6,344	1,536,643
Negri Sembilan	607	147,167
Pahang	786	190,339
Total	19,735	4,780,978

Other minerals produced were: gold, 9,966 troy oz.; coal, 190,897 tons (all from Selangor); china clay, 63 tons; haematite, 272 tons (all from Perak); wolfram, 7 tons; scheelite, 14 tons; and amang, 1,548 tons.

MALAY STATES (UNFEDERATED) AND MALACCA

It is regretted that the usual quarterly return of exports of minerals furnished by the Chief Inspector of Mines is no longer available for publication.

JOHORE

The following progress report on mining in the State of Johore during the first quarter of 1940 has been compiled from a statement submitted by the Acting Warden of Mines.

Tin Ore.—The production of tin ore continued to be regulated, and exports cannot be greater than the permitted quota release for each quota period, which corresponds to a quarter of a year.

Exports of tin ore from all sources during the three months January to March amounted to 306·1 tons, valued at $476,598·12. This represents a decrease of 39·35 tons exported as compared with the previous quarter.

During the first quarter the tin ore exports from Johore Bahru amounted to 176·05 tons, from Kota Tinggi 103·38 tons, and from Penggerang 26·67 tons.

The proportions of tin ore exported from European owned or managed mines fell from 60·56 per cent. during the last quarter of 1939 to 50·07 per cent. during the first quarter of 1940.

Iron Ore.—Exports of iron ore for January amounted to 43,622·81 tons, for February 49,602·8 tons, and for March 53,955·2 tons. The total export of 147,180·81 tons being valued at $735,904·05. Owing to the monsoon none was exported from Endau (East Coast), the whole amount going out from Batu Pahat (West Coast).

In Johore iron ore is valued at $5·00 per ton for the purpose of assessing export duty, which is 10 per cent. *ad valorem.*

Bauxite.—Two open-cast bauxite mines were worked during the quarter. The Kim Kim mine, which is situated near Pulau Nanas on the south coast of Johore, was not operated. The exports of ore amounted to 7,969·46 tons in January, 2,953·64 tons in February, and 6,396·82 tons in March. The total of 17,319·92 tons, valued at $86,599·6, was exported entirely from Batu Pahat on the west coast.

In Johore the assessment valuation and export duty for bauxite are estimated at the same rate as for iron ore, the value being $5·00 per ton, and the export duty 10 per cent. *ad valorem.*

Gold.—A total of 6·7499 troy oz. of gold, valued at $391·48, was produced during the quarter from two small opencast workings in the alluvial at Sungei Papan, Kota Tinggi district, and from a mine

at Jemaluang, Mersing district, where gold occurs with alluvial tin ore. The output for the previous quarter was 2·593 troy oz.

A royalty of 2½ per cent. *ad valorem* is paid on all gold produced.

SARAWAK

The Chief Secretary reports that the production of gold for the period December 1, 1939, to February 29, 1940, was 2,820 fine oz., of which 29 oz. came from the Kuching District and the remainder from the Bau District. The area covered by Mining Leases at the end of February was 6,703 acres, and, of the 40 leases extant, two cover quicksilver and the remainder gold and silver. Seven Exclusive Prospecting Licences for gold and silver, each issued for a term of one year, and covering in all 1,316 acres, were in existence on February 29, 1940.

A few small pockets of antimony ore are being worked in a desultory fashion by fossickers, and the grade of ore produced is generally low. Thirty tons of this ore were exported during the above-mentioned period.

SIERRA LEONE

The Acting Chief Inspector of Mines reports the following mineral production for the first quarter of 1940. The corresponding figures for the first quarter of 1939 are shown for comparison:

Mineral.	January to March, 1940.	January to March, 1939.
Gold—crude and unrefined bullion	11,096 *troy oz.*	11,528 *troy oz.*
Gold—estimated fine gold . .	10,105 "	10,634 "
Platinum—coarse crude . .	56·7 "	31 "
Chromite	4,792 *tons*	nil

The figures for diamond production and iron ore exports are not available.

The average number of Africans employed in prospecting during the quarter was 182. Those employed in mining numbered 16,767, and in miscellaneous services in connection with the industry 369.

TANGANYIKA

The following notes on minerals and mining in Tanganyika during the first and second quarters of 1940 have been received from the Acting Chief Inspector of Mines and Chief Geologist.

Production and Export.—Notwithstanding the rise in prices of many items used in mining, production of minerals during the period has in most cases shown a satisfactory increase over that for a similar period in 1939. This is attributable to some extent to the rise in the price of gold and tin, and also to the efforts being made to produce more minerals to combat the present economic emergency.

The statement below shows a steady improvement in the exploitation of reef gold, cassiterite and wolframite, and salt.

Exports of gold during the second quarter increased in value by nearly £20,000 compared with similar exports for the first quarter. During the half-year an increase of 46 per cent. by value was recorded for the total exports compared with the corresponding period for 1939. The export of gold has been interrupted to some extent by alterations in the air-mail schedules.

Exports of tin-ore continued to increase during the period under review, the recorded increase in value for the half-year being 37 per cent. compared with the corresponding exports for the first half of 1939.

MINERAL EXPORTS FOR 1ST AND 2ND QUARTERS OF 1940

Mineral.	Locality.	1st Quarter			2nd Quarter		
		January.	February.	March.	April.	May.	June.
Gold; lode or reef	Musoma	£32,250	£34,473	£26,732	£29,615	£38,690	£23,300
	Mwanza	£24,890	£21,815	£25,281	£35,235	£14,965	£44,315
	Lupa	£28,075	£27,598	£24,398	£22,035	£17,012	£23,275
	Iramba	£7,629	£6,149	£7,164	£8,710	£7,889	£5,505
	Total	£92,844	£90,035	£83,575	£95,595	£78,556	£96,395
Gold; placer or alluvial	Lupa	£9,867	£12,614	£13,559	£16,690	£12,945	£9,935
	Ukonongo	£1,457	£1,629	£2,714	£2,440	£1,375	£150
	Ruvu River	£172	Nil	£184	Nil	£39	Nil
	Iramba	Nil	Nil	Nil	Nil	£90	Nil
	Total	£11,496	£14,243	£16,457	£19,130	£14,449	£10,085
Gold-bearing concentrates	Lupa Goldfield	Nil	Nil	Nil	Nil	£400	Nil
Diamonds	Lake Province	£306	£470	£283	£520	£330	£100
Cassiterite and wolframite	Karagwe Tinfields	£5,895	£6,135	£5,285	£8,250	£4,365	£6,055
Salt	Uvinza	£2,743	£2,454	£2,154	£1,895	£2,962	£1,560
Mica; sheet and waste	Morogoro; Kigoma	0·1 tons £25	5·1 tons £2,500	2·2 tons £900	Nil Nil	0·8 tons £250	Nil Nil
Talc powder	Hedaru Tanga Province	Nil	£24	Nil	Nil	Nil	Nil

Although there has been no noteworthy increase in market prices, a steady demand is stated to exist in England for mica of the best quality and size, and efforts are naturally being made to meet this demand, but much mica of poorer quality and size must perforce be shipped. This serves only to glut the market with medium-priced stuff and to depress prices—a state of affairs that can be counteracted only by the possession of large financial reserves on the part of the producer, by a closer study of the market for medium-priced products, and by reducing the time-lag between

production and realisation. Unfortunately, most of these palliatives are almost impossible to apply, especially under war conditions.

While the export of gold-bearing concentrates is nil for the first quarter, production for the second quarter made an improvement. This commodity also suffers from the handicap of an adverse time-lag before realisation, and the question of its improvement is under examination.

Exports of diamonds decreased in the second quarter; an explanation for this can be found in the present restricted postal facilities between East Africa and London.

The value of the salt exported remains fairly steady.

Prospecting.—A welcome increase in the number of lode-gold claims pegged on the Lupa Goldfield took place during the first quarter, due to some extent to the lapsing of certain exclusive licences granted five or six years ago when speculators were active in the Territory. Claims are also being pegged to a smaller extent in the Mwanza Goldfield. During the second quarter the number of claims pegged decreased, but applications for new exclusive prospecting licences were received.

In the Karagwe Tinfields prospecting and mineral exploitation is being accelerated by the exercise of greater administrative control.

New Features.—No new mills have been installed during the period on any of the goldfields, but notification has been received of preliminary attention being given to this matter in two or three instances. Machinery for a new mill to be erected on the Lupa Goldfield is said to be on its way from America; one small producer in the same field ceased production at the end of the quarter owing to seasonal water shortage. In the Musoma Goldfield an Inspector has been active giving technical advice to small operators in their mining and metallurgical problems; the Government Metallurgist has visited the Iramba and Lupa Goldfields on a similar errand, and a Geologist has performed useful mining-geological research in the Iramba Goldfield. In the Lupa Goldfield, news has been received that a mining engineer has established himself in private practice as a mining consultant.

The supply of mining materials from abroad continues to give no cause for alarm, although prices of certain items are said to have risen steeply in outlying districts where local stocks are small.

UGANDA

The following report has been received from the Director of the Geological Survey regarding mining activities in Uganda during the period April to June 1940.

Gold.—The output of gold for the second quarter shows an increase on the previous three months, but the amount is still somewhat below that of last year. Provisional figures show that 3,243 fine oz. were produced, valued at £27,239.

A new area in Northern Kigezi which is at present being mapped by an officer of this Survey is suggested as worth prospecting.

New lodes are still being discovered at the Borderland property at Busia on the Kenya border, where some 11,000 ft. of quartz have been brought to light since the beginning of February; details of other finds are not yet to hand. All these quartz lodes appear to belong to the same channel which, although on the average narrow at the surface, shows excellent values. No capital, however, can be obtained at present to develop this property, and underground work has been suspended. The area is now worked entirely by open-cast methods.

Similarly no work is being done on the promising country to the north held by another company.

Tin.—During the period April-June, 107,666 tons of tin ore, valued at £20,836 (provisional figures) were exported. This amount is much less than that recorded for the corresponding period of 1939 but, owing to the fluctuating quantities released from stock, no definite conclusion can be drawn regarding any possible falling off of output.

Tantalite.—One ton of high-grade tantalite, provisionally valued at £316, was exported in May. Work on the deposit is still being continued. The ore is found on the edge of an irregular quartz body whose extent has not yet been ascertained.

ABSTRACTS AND NOTES

Obituary—Mr. G. S. Blake.—It is with very deep regret that we have to record the death early in July of Mr. G. S. Blake, B.Sc., A.R.S.M., F.G.S., M.I.M.M., a former member of the staff of the Imperial Institute. Mr. Blake was murdered by armed bandits while engaged on geological field work in Palestine. He joined the staff of the Scientific and Technical Department of the Imperial Institute in January 1901 and remained until March 1909 when he left to undertake exploratory work in the Matto Grosso, Brazil. Throughout this period Mr. Blake was mainly engaged on laboratory duties in connection with the mineral surveys of Ceylon and Nigeria then being conducted by the Institute. He published jointly various mineralogical papers, notably on " Thorianite, a new mineral from Ceylon," in conjunction with Professor W. R. Dunstan, on " Carnotite and an associated mineral complex from South Australia " in conjunction with Thomas Crook, late principal of the Mineral Resources Department, and on " Baddeleyite from Ceylon," and " Varieties of zirkelite from Ceylon " in conjunction with Dr. Herbert Smith.

Mr. Blake is perhaps best known for his investigations into the geology of Palestine, where he spent many years as Geological Adviser to the Government of that country. Amongst his other

achievements he produced a geological map of Palestine and investigated the waters of the Dead Sea, while his " Mineral Resources of Palestine and Trans-Jordan" and "Water Resources of Palestine" are standard works.

At the time of his death Mr. Blake had emerged from retirement to undertake geological work in Palestine for a private company.

The Mineral Resources of the Gwanda District, Southern Rhodesia.—The country around the township of Gwanda in Southern Rhodesia has long been known as a mineralised zone, nearly a million ounces of gold having been won from the numerous mines of the district. The need, however, for an up-to-date and authoritative account of the geology and mineral resources of this area has often been felt, with the consequence that Mr. R. Tyndale-Biscoe visited the region during the period 1935 to 1938 and surveyed a tract of 1,536 sq. miles. The results of his work, together with an excellent geological map on the scale of 1 : 100,000, the topography of which is based on an aerial survey made by the Aircraft Operating Company of Africa (Pty.), Ltd., are summarised in a recent Bulletin of the Geological Survey of Southern Rhodesia (*Bull.* 36, Salisbury, 1940, 204 pp.), from which the following notes have been abstracted.

The Gwanda district consists of a highly folded mass of metamorphic rocks, collectively known as the " Basement Schists," varying in composition from ultrabasic to highly siliceous, and in structure from massive to strongly schistose: it is completely surrounded by a remarkable variety of granitic rocks forming portions of large batholiths. One peculiar feature of the area is the abundance of crystalline limestone, a rock which is comparatively scarce in Southern Rhodesia as a whole; it is thought that this limestone is of magmatic origin.

Gold.—The total gold production of the district up to the end of 1938 amounted to 998,031 oz., worth about £4,241,580 at standard value. Nearly half of this has come from the mines of the Eastern group. The number of registered producing properties is 268, of which not more than 42 have been worked to depths exceeding 100 ft.; only 12 have been worked below depths of 125 ft. The following is a list of properties with total production exceeding 10,000 oz. gold.

Eastern Group

Name of Property.	oz.
Geelong Jessie Nicholson (with Olympus) Valley	253,107
Bucks Reef	45,352
Colleen Bawn	28,676
Farvic	51,544
Prestwood	13,917
Prince Olaf	23,052

Central Group

Name of Property.	oz.
Abercorn	68,489
Antenior	63,826
Big Ben	35,731
Eagle Vulture	17,926
Imani	15,980
Minnie's Luck	12,935
Sabiwa Group	
Blanket	44,521
Long John Sabiwa	80,412
Lady Lina (with Magano) Susanna	51,420
Tuli Group	
Horn Reef	13,417
Lone Hand	14,064

Arsenic.—The production of arsenic from the Gwanda district has been as follows:

Champion mine (1914-1926)	1,119 *tons*	Value	£35,295
Hydra mine (1924-1930)	398 *tons*	,,	£9,638
Posho mine (1923)	1 *ton*	,,	£33

Arsenopyrite occurs abundantly in the mineral deposits of the Gwanda gold belt, mainly in the western portion, but only in the above properties has the mineral been found to occur in workable concentrations.

Asbestos.—The only locality in the Gwanda district where asbestos has actually been mined is in the hills immediately south of the Jessie mine. The property was known as the Laninhurst claims, and was pegged in October 1936. The material was slip fibre, but no output has been declared, despite much development work.

Copper.—The largest deposit of copper (in the form of chalcopyrite) noted in the area is in the Valley mine. A smelter was erected at this mine in 1906, and 360 tons of copper, valued at £23,000, was produced up to 1911. Since then there has been a production of only about 2 tons (from 1915 to 1917), valued at £178.

The Black Mamba reef carries a noteworthy amount of copper, while small quantities occur in the Gift, Imani, Jessie, Prince Olaf, and other reefs.

Ironstone.—A small deposit of soft, porous limonite was recently opened up at the Hampden Claims, the ore carrying 47·45 per cent. iron. A similar deposit has also been opened up on the east side of the railway line in the north corner of Spitzkop farm, about 1½ miles north of Gwanda. This ore carries 60·26 per cent. iron and 7·88 per cent. silica.

On account of the lack of local markets for iron ore, however, no systematic investigation has been undertaken to determine the potential reserves of this commodity in the Gwanda district.

Limestone.—The Gwanda district is exceptionally rich in deposits of crystalline limestone. The mass at Colleen Bawn is probably the largest single deposit in the Basement Schists of Southern Rhodesia. It is quarried at the rate of nearly 8,500 tons a month and sent by rail to the Premier Portland Cement Company's factory near Bulawayo. The output for the years 1936 to 1938 was 266,663 tons, valued at £8,263.

Blue and white limestones are quarried at the Antenior Lime Works, the output during 1937 and 1938 being 327 tons, valued at £163.

The Tuli Lime Works produced 1,271 tons of limestone, valued at £481, during the period 1936 to 1938.

Magnesite.—At two places in the serpentine masses of the district magnesite veins are developed. One is on Thornwood Block, to the south-east of Antenior Siding and east of the Lime Works, the other on Moord Spruit farm. Some trenching was carried out on the former occurrence, but the veins were too small and impersistent for profitable exploitation.

Pyrite.—Deposits of massive pyrite have been opened up at the Primus mine, on Forest Hill farm, and at the Unreliance mine on Tuli River farm. The tonnage available, however, does not seem sufficient for economic exploitation.

Scheelite.—This mineral occurs in many gold-bearing quartz veins in the district, but only at the Jounie mine has the quantity encouraged consideration of concentrating it as a by-product. Two concentrates from this mine gave 43·02 and 41·58 per cent. WO_3 respectively, but the samples contained appreciable amounts of magnetite and pyrite.

Silver.—Silver occurs associated with the gold ores and in various sulphide deposits.

The Mineral Resources of the Russian Arctic Hinterland.—Immediately after the Great War, in January 1919, a small group of scientists in Russia formed a Commission for the study of the Arctic. A comprehensive plan was drawn up, beginning with the examination of the Kola peninsula and Novaya Zemlya, but capable of expansion later. Twenty-three expeditions were equipped, and by 1925 the survey of the shores of Novaya Zemlya was completed, including much geological and hydrographical work.

In 1925 the Commission became the Institute for Arctic Study, and eventually, in order to facilitate future developments, a new central organisation was created, the Central Board of the Northern Sea Route, of which Professor Schmidt was appointed Chairman. By a series of decrees dated December 17, 1932, March 11, 1933, and July 20, 1934, this Administration was put in charge of all matters, economic and scientific, dealing with the country north of lat. 62° N. These matters included all details connected with the development of the sea-route and its hinterland, the location,

construction and equipment of ports and refuelling bases, the economic exploration of fuel and other resources, hydrographic and other surveys, colonisation and sovietisation of the hinterland, and the provision of labour for development and research.

A brief survey of the development of the mineral resources of this area has recently appeared in Notes on the Northern Sea Route, by Professor Kenneth Mason, *Geol. Journ.*, XCVI, No. 1, July 1940, from which these abstracts are taken.

A number of expeditions have been engaged during the last ten years on geological surveys and in prospecting for minerals. As a result, much has been written of the " vast resources " of the Arctic shores and hinterland. It is, however, still difficult to ascertain the success of these exploratory efforts. As soon as traces of a mineral are found, they are hailed as " resources," and before a detailed survey is made the mineral appears in lists of resources available.

A list of mineral resources claimed in 1934 to exist in the Soviet Arctic was published by L. Shishkova in the *Bulletin of the Arctic Institute*, Leningrad. Many of the deposits mentioned, even if large, would be difficult to exploit without overcoming great difficulties in transport, and in many cases no steps appear to have been taken to develop them. The list therefore indicates only that traces of the minerals mentioned have been found : no occurrence referred to away from the main lines of communications of the Northern Sea Route—that is, away from the accessible parts of the coast or away from the navigable rivers—can at present be classed as exploitable. With the exception of a small 70-mile railway from the Noril'sk mines to Dudinka there are no communications in the immediate hinterland other than rivers. Dog-sleigh and aero-sleigh in winter do not lend themselves to economic transport ; in spring the tundra marshland is a great handicap to travel, and floods from rivers still blocked in their lower reaches by ice make impassable great stretches of lowland ; in summer, perhaps for three months, development is possible if sufficient labour is available, but this labour must either be brought in for the season or fed in idleness for nine months of the year.

Comparing the list given by Shishkova (*Bull. Arctic Inst., Leningr.*, No. 10 (1934), 37) with later accounts, it appears that the exploitable resources are :

(*a*) Copper, zinc, asbestos, iron, lead, in Novaya Zemlya, if they exist in sufficient quantities. (Zinc ores were reported near the south shore of the Matochkin Strait, and lead in the north island of Novaya Zemlya in 1932. They do not appear in Shishkova's list.)

(*b*) Coal from (i) Noril'sk, near Gol'chikha, and from the Pyasina river, all of which are near the Yenisei or Pyasina navigable routes ; (ii) the Kheta tributary of the Khatanga river and perhaps near Nordvik itself on the Nordvik route ; (iii) the Sangarkhaiskiye (" Sangarskoe ") Mines and possibly Bulun and Tiksi Bay shore, on

the Lena route; (iv) Ziryanka on the Kolima-Ambarchik Bay route; and (v) Ugol'naya and Providence Bay on the Anadir Gulf, north-west Pacific.

(*c*) Copper and nickel from Noril'sk, exploited *via* Dudinka on the Yenisei.

(*d*) Rock salt from the Nordvik neighbourhood.

(*e*) Graphite from the Lower Yenisei region.

Oil indications have been found in Inostrantsev Bay, Novaya Zemlya, on Begichev Island near Nordvik, and close to the shores of Chaunskaya Bay. If the indications are proved in sufficient quantities, they are close enough to the Northern Sea Route for the installation of a pipe-line. Some recent optimistic reports have appeared regarding the Nordvik indications, but there is no reference to mechanical preparations for the development of oil in the Soviet Arctic. At present it may be safely assumed that no oil is in the productive stage. In 1939 Papanin reported that "valuable results have been achieved by the Nordvik expedition prospecting in Kozhevnik Bay for oil, coal and rock-salt." In fact, it was in 1933 that traces of these minerals were first found; they are included in the 1934 list, and in 1936 the first salt was mined and advertised as having reached the productive stage. Neither of the two other commodities have been so advertised, and it appears that prospecting is still going on. In *Pravda* on September 6, 1939, Papanin wrote: "Nevertheless, the problem of coal is still acute for us on the Northern Sea Route," and though he stated that there was no reason why the entire Arctic fleet should not be fuelled in the future from local sources, the only mines he actually mentions are the Sangarkhaiskiye, and those at Noril'sk, Ziryanka, and in Providence Bay.

"Prospecting may still discover useful local fuel resources. In the region of Ust'-Yeniseiski Port a prospecting expedition is actively seeking oil, and the Western Taimir coal prospecting expedition is looking for coal on the shores of the Kara Sea. . . . We have every reason to hope that in the near future big coal and oil industries will grow up along the Northern Sea Route, which will provide fuel not only for the Arctic fleet, but also for the new settlements and towns arising on the Arctic coast. There should be no reason to import fuel to the Arctic, for the Arctic possesses its own natural resources of coal, oil, and rare metals." (*Pravda*, November 22, 1939.)

Ore Reserves, Estimated Life and Development Costs of some Australasian Gold Mines.—An interesting article on this subject dealing with representative gold mines of Australia, New Zealand, New Guinea and Fiji has recently been compiled by the editorial staff in the *Chemical Engineering and Mining Review* for May 10, 1940, pp. 309-311. The majority of the Australian mines considered in this article are located in Western Australia: unfortunately

few of the gold mines in Victoria issue ore-reserve estimates, while some of the smaller mines elsewhere either do not publish their reserves or the information available is incomplete.

ORE RESERVES, ESTIMATED LIFE AND DEVELOPMENT COSTS OF REPRESENTATIVE GOLD MINES IN AUSTRALASIA

Company.	Ore Reserves.			Years' Life.	Development costs. (Australian currency.)		
	Date of Estimate.	Long tons. (1,000's.)	Dwt. per ton.		Total.	Per ton developed.	Per ton milled.
Western Australia					£	s. d.	s. d.
Lake View and Star	1-7-39	3,665*	5·6	5·6	82,671	2 3	2 6
Wiluna Gold Mines Ltd.	31-3-39	1,468*	3·9	2·4	163,961	22 3	5 6
Great Boulder	31-12-38	1,213*	6·5	3·0	80,586	3 7	5 5
North Kalgurli (1912)	31-12-38	982	7·6	4·8	38,285	4 4	5 9
Sons of Gwalia	31-12-38	930*	6·4	6·0	28,072	3 2	3 8
Norseman G.M.:							
Norseman Mine	31-10-39	312*	5·2	4·1	21,382	2 2	3 7
Iron King Mine	31-10-39	430*	2·3				
Gold Mines of Kalgoorlie	31-3-39	670	5·2	4·6	21,391	1 0	4 7
Kalgoorlie Enterprise	31-12-38	439	7·2	7·3	(a)	(a)	3 9
Boulder Perseverance	31-12-38	401	7·2	3·6	26,942	(a)	4 10
Paringa	31-8-39	397	5·0	4·7	20,731	2 0	5 11
Triton	31-3-39	317	7·0	2·8	42,395	6 3	7 7
Mt. Magnet	31-3-39	317*	3·7	5·3	5,720	2 3	1 11
South Kalgurli	31-3-39	260*	5·2	2·8	25,049	7 5	5 7
Hill 50	1-6-39	220	5·7	9·0	1,389	2	1 4
Youanmi	30-6-39	193*	8·5	1·6	36,117	8 9	8 1
Lancefield	1-8-39	158*	5·0	0·9	31,761	5 0	4 6
Ora Banda Amalgamated	28-2-39	27	8·0	1·4	13,159	13 6	13 10
Queensland							
Mt. Morgan	28-6-39	6,993	4·2	13·5	(a)	(a)	(a)
Golden Plateau	30-6-39	223	5·0	2·7	18,002	4 1	4 6
New South Wales							
New Occidental:							
New Occidental Mine	30-11-39	580	8·0	6·0	45,278	2 2	6 7
New Cobar Mine	30-11-39	289	7·8	6·0			
Victoria							
Maude and Yellow Girl	30-6-39	42	(a)	5·0	5,480	4 2	26 8
New Guinea							
New Guinea Goldfields	30-9-39	150	(a)	2·0	27,741	5 0	8 4
Cuthbert's Misima	31-12-39	308	(a)	7·7	4,187	2 7	2 3
New Zealand							
Martha (Waihi)	31-12-38	284*	7·3	1·4	26,814	2 9	2 7
Blackwater	31-12-38	92	9·5	2·1	12,435	4 11	5 9
Fiji							
Emperor	6-9-39	839	8·3	4·7	33,607	3 11	3 9
Loloma	6-9-39	142	24·8	5·1	17,342	11 4	12 6

(a) *Information not available.* * *Company reports in short tons.*

Of the sixteen gold mines in Western Australia which are considered and which contributed in 1939 some 60 per cent. of the gold production of the State, it is estimated that their total ore reserves amount to 11,450,000 long tons and that their combined plant capacity is 2,900,000 long tons annually, indicating an average life of 4 years. The average grade of ore for these mines is given as 6·11 dwt. gold per ton. Other interesting data, abstracted from the above article, are given in the table on page 371.

Tantalum Minerals in Uganda.—The *Annual Report of the Geological Survey Department* for 1939 gives some interesting facts concerning tantalum minerals in the Uganda Protectorate.

The exports of tantalite, which in 1927 reached a maximum of 27·095 tons, valued at £5,979, had decreased to 8·958 long tons in 1938, valued at £1,408, and 3·578 tons in 1939, valued at £869. However, interest in tantalite revived somewhat amongst the miners owing to a good offer from one firm for ore with a high percentage of tantalic oxide. The discovery by Mr. Roberts early in 1939 of a lode with high-grade tantalite and proof by the same officer of the widespread occurrence of these ores in Western Buhwezu has also encouraged their prospection. Further, the discovery of concentrations of tantalite-columbite in southern Toro considerably widens the area of possible occurrence, and it is stated that, if encouragement is lent by the final sales figures of the tantalite now being worked on the Jemubi river, the working of ore of this type should expand considerably.

The presence of tantalite in the alluvial deposits of the Buhwezu plateau has been known for some time, but Mr. Roberts has been able to locate five occurrences of tantalite minerals *in situ* in the Jemubi river valley, near the confluence of this river with the Hoindagi river; of these, four are of no economic importance. Both tantalite and columbite have been discovered in the valleys of the Jemubi and Hoindagi associated with gold in the alluvial gravels, but these deposits are too low grade to work except where payable values of gold are present. In two tributary valleys, however, payable tantalite values have been found over 25 and 125 yards respectively along the streams. Since these valleys are very narrow, however, the quantity of ore that could be recovered would be comparatively unimportant.

Consequently, the conclusion is drawn that, so far as can be seen at present, tantalite-columbite cannot be profitably recovered from alluvial deposits except in small quantities as a by-product of gold mining. It becomes necessary, therefore, to find payable deposits of the mineral *in situ*. Tantalite is widely distributed along the Jemubi river and its numerous tributaries, as far as the foot of the escarpment, so that strong indications from which to start the search for reef deposits are not lacking. Moreover, the

fact that most of the tantalite particles to be found in the streams are very angular, proves that the mineral is of local origin.

During May 1939 a deposit of tantalite *in situ* was discovered near the Jemubi river. The mineral occurs at the contact of a quartz vein with the underlying coarsely crystalline quartz-muscovite aggregate. This deposit is now being worked by the Bysia Syndicate.

The tantalite of this latest discovery is of considerable interest in that it is of unusually high grade and equivalent to the best Australian material. Moreover, it is almost free from tin. A sample was received at the Imperial Institute where an analysis of picked specimens, separated as far as possible from adhering quartz, gave the following results: Ta_2O_5 83·39; Cb_2O_5 1·46; FeO 11·13; MnO 2·64; TiO_2 0·34; SnO_2 0·03; Total 98·99. The specific gravity was 7·78. Tantalum manufacturers require ore with a high tantalic oxide content (80 per cent. or more), coupled with not more than a few per cent. of columbic oxide and a low tin content; this requirement is well met in the above instance. It is also of interest to note that the Ta_2O_5 content of 83·39 per cent. closely approaches the theoretical maximum (86·1 per cent.).

An interesting mangano-tantalate of iron was discovered in concentrates from an alluvial gold-mine and later in its original pegmatite veins. Samples have been received at the Imperial Institute,and their precise nature is at present under investigation.

Mercury in British Columbia.—In view of the fact that a high proportion of our supplies of mercury normally originate in Italy and Spain, the efforts towards self-sufficiency in Canada, which have been stimulated by the present situation and the high price of the metal, are worthy of note.

Deposits of cinnabar have been known for a considerable number of years in British Columbia, the most important of which are those situated at Pinchi Lake to the east of Stuart Lake in the Fort St. James district. The latest developments at this property, which was recently visited by the British Columbia Minister of Mines, have been so encouraging that an increase in the capacity of the plant from 75 to 100 tons per day is stated to be under consideration. According to the *Northern Miner*, June 27, 1940, ore valued at $40 per ton is being treated at this plant, which is expected to produce mercury to the value of $750,000 in the first year of operation. As these calculations are based on a mercury price of $2·50 per lb. at the time of the Minister's visit, it would appear that the ore averages 16 lb. of mercury per ton. This 0·8 per cent. ore, therefore, may be compared with an average of 5 per cent. in Spain, 0·79 per cent. in Italy, and 0·35 per cent. in the United States.

A detailed description of the Pinchi Lake deposit and others in this province has recently been made by John S. Stevenson in

Bulletin No. 5, British Columbia Department of Mines, from which the following abstracts have been taken.

Pinchi Lake.—The discovery of cinnabar at this locality was made in the summer of 1937 by J. G. Gray, of the Geological Survey of Canada, and is described by him in a report on the East Half, Fort Fraser Map-Area, B.C., *Geol. Surv. Canada, Paper* 38-14, 1938, p. 9, but the original claims were not staked until May 1938.

The Pinchi Lake cinnabar deposit consists of a cinnabar-bearing fracture-zone that cuts a series of dynamically-metamorphosed sediments. The rocks include limestone, cherty quartzite, quartz-mica schist and glaucophane schist. These rocks strike more or less uniformly north-westerly and dip north-eastward, but in the vicinity of the showings they have been warped into a structure that the writer interprets as a combined anticline and syncline that strikes northerly and plunges from 25 to 60 degrees in the same direction. The fracture-zone strikes N. 60-70° W., at times parallel to the bedding but cutting across the strike of the folds. This fracture-zone is characterised underground by extreme faulting and associated brecciation over widths ranging from 6 in. to 4 ft., and on the surface by disconnected outcrops of brecciated chert, the widths of brecciation ranging from 2 ft. to 10 ft. The length of the fracture-zone (which, however, is not uniformly mineralised) may be summarised as follows: (1) Length of definite fault-zone and associated brecciation as seen in the main drift of the north adit—230 ft. (as of June 11, 1939); (2) Length of fracture-zone in the showings on Discovery Hill as indicated by fairly closely-spaced strippings and outcrops exposing brecciated rock—750 ft.; (3) Overall distance between outcrops of brecciated rock at extremities of partly-prospected area and separated by long unprospected areas of drift—4,000 ft.

Cinnabar occurs most abundantly in the highly-brecciated fault or fracture-zone material of both the south-easterly and north-westerly workings over widths corresponding to those of the fracture-zone, and, in the cherty quartzite of the north-westerly workings over widths ranging from 1 in. to 4 ft.

The cinnabar indications are found on two knolls situated a quarter of a mile apart along the 200 ft. wide top of a rounded limestone ridge approximately 700 ft. high running parallel to the north shore of the lake. The southerly slope of the ridge begins to rise steeply a few hundred feet back from the wooded shore of the lake and rises on a slope ranging from 25 to 30 degrees; for the most part the hillside consists of talus slopes and low bluffs, clothed in part by a dense covering of small timber.

The distribution of cinnabar is more or less coincident with the fracture-zone. The heaviest concentrations of cinnabar occur where brecciation and shearing of the fracture-zone material appears most intense and the limestone most siliceous. This type of ore consists predominantly of scattered grains and clusters of grains,

and, to a less extent, of uniform mineral sheets. The cinnabar also occurs in weaving wisps or streamers of variable width within very finely-comminuted material between larger breccia-fragments. The ore-zone breccia consists of angular fragments of chert set in a pulverised matrix of fine grains of quartz, carbonates, and sometimes epidote and sericite; the texture is definitely that of a crush- or fault-breccia and, as such, forms a very good host for the cinnabar. Samples taken across 1-ft. and 18-in. widths of breccia well charged with cinnabar have been shown by assay to contain 1·09 per cent. and 1·43 per cent. of mercury.

The widths of better mineralised rock more or less correspond with those of the crush- or breccia-zone, and are usually very poorly defined. In general, the widths of good mineralisation range from 6 in. to an observed maximum of 4 ft. The only place where a confining wall is evident is underground in the main drift of the north adit. Cinnabar does not occur in the foot-wall of the main fault, although it extends for irregular distances into the hanging-wall.

Favourable conditions for ore-deposition, as opposed to sparse occurrences of ore, appear to have been in part: (1) the presence of highly-comminuted, crushed and brecciated material related to the fracture-zone; (2) the occasional presence of crushed quartzite; (3) possibly the occurrence of schistose and, therefore, relatively impervious phases of the sediments that seem to have acted as local barriers to rising solutions and which aided in the concentration of cinnabar into ore-shoots.

Kamloops Lake and Vicinity Occurrences.—Cinnabar occurs at several places within a belt approximately 8 miles wide that extends for 11 miles northerly and for approximately the same distance southerly from the west end of Kamloops Lake. The deposits consist of shear-zones and dolomite veins that contain varying amounts of cinnabar. The rocks are greenstone of the Nicola group, which, in the vicinity of the deposits, have usually been intensely altered by ankeritisation. The occurrences include the following deposits: Copper Creek cinnabar claims; Hardie Mountain cinnabar deposit; Sabiston Flats; Davis showings; Criss Creek showings; Charbonneau showings near Savona Station on the Canadian Pacific Railway; showings in the vicinity of Tunkwa Lake. During the period 1895 to 1897, 138 flasks of mercury were produced at the Copper Creek workings, and when they were reopened during the years 1924 to 1927 a further 5 flasks were obtained. There are no records of production from the other properties.

Other Occurrences.—Other deposits of mercury ore in British Columbia include those in the Yalakom River, Bridge River (where 10 flasks were produced in 1938), and Alberni Canal districts, the geology and mineralisation of which are also described in detail in the bulletin.

Selenium as an Ingredient in Stainless Steels.—The use of selenium as an ingredient in stainless austenitic nickel-chromium steels has recently been described by L. Sanderson in *Canadian Mining Journal*, June 1940, p. 371. According to this writer, the austenitic "18/8" steels possess the remarkable property of "work-hardening," whereby as soon as they are cut, abraded, or in any way " worked " on the surface, they begin to take on extreme surface hardness, so that the tool breaks down, or the work becomes increasingly difficult. One way of overcoming this difficulty, says the writer, is to raise the sulphur percentage in the steel, thus producing a softer metal and one more readily machined. This practice has the disadvantage in that it lowers the mechanical strength of the steel considerably, as well as lessening the corrosion-resistance to some extent. The addition, however, of a small percentage of selenium to the steel has the effect of increasing its machinability without in any way affecting its corrosion-resistance, and without appreciably altering its mechanical properties.

New Uses for Asbestos.—A number of new uses for asbestos are described by F. R. Cozzens in *Asbestos*, **22**, 1, July 1940. One application is as a shock absorber in blasting to prevent crumbling of the rock immediately beneath the shot hole. Short fibres are used for filling and tamping an extra pocket in the bottom of the hole. Quantities of from six ounces for ordinary blasting to several hundred pounds for reservoirs in oil or gas wells are used and soften the downward kick of the explosion. The fire-resisting qualities of the material prevent any burning-up due to the heat of detonation.

Other recent applications in the explosives field include an asbestos-latex compound for sealing electric blasting-caps, an asbestos-rubber insulation for contact wiring, and strainers of fine-combed asbestos yarn used in the filtration of sulphuric and nitro-hydrochloric acids.

A new core for the spooling of fast-moving ropes is made of rubber containing 20 per cent. asbestos fibre to lessen wear caused by the heat of friction. To eliminate " sun-rot," cable and cordage are wrapped in asbestos-felt cemented to a canvas backing. A similar wrapper is used to protect cordage against corrosion by salt when transported by sea.

Asbestos lumber and asbestos-felt liners are now used in fruit and vegetable storage as it is found that fungal spores will not collect and reproduce as they do when wood and cloth are used. In testing vegetable seeds it is said that asbestos mats give a more uniform germination than those of burlap. Asbestos insulation is useful in the prevention of temperature fluctuation in fruit and vegetable storage.

Other applications include an aluminium-asbestos paint for underground pipe protection; an asbestos shield for the slow tempering of bits; plastic cements for replacing concrete in seating

casing; swabs for cleaning boiler flues; asbestos-lined funnel vats for reclaiming waste oil; asbestos-sponge filters for removing sludge in air compression work; and asbestos-resin dressing for high-speed friction belts.

Rahn Lake Asbestos Mine.—Practically the whole Canadian asbestos production comes from the Province of Quebec, but for some years a deposit has been operated in a small way in Ontario by the Rahn Lake Mines Corporation. The possibility of developing this deposit has lately been looked into by Johnson's Company of Thetford Mines; their preliminary examination has resulted in the finding of promising indications, and they are reported to have agreed to provide substantial financial assistance in the proper development of the property (*Asbestos*, June 1940, p. 26).

Diatomite in the Filtration of Plating Electrolytes.—The filtration of electroplating solutions has recently been surveyed in a paper by A. I. Wynne-Williams presented to the Electrodepositors' Technical Society. In addition to describing operating methods and types of plant employed, the paper (from which the following abstracts are taken) reviews the principles and practice of employing diatomite as the filtering medium for insoluble impurities.

Filtration of the electrolyte in electrodeposition processes is now considered to be one of the essential conditions of producing a product of good quality. Solid material found in an electrolyte may be divided into two classes—coarse particles and fine particles, and each of these two classes of material may be subdivided into soluble material and insoluble material.

Although the deleterious effects of these two classes of material may be quite different, the former being the cause of rough deposits and the latter a source of contamination of the electrolyte, they can be considered together because a filtration system that will deal satisfactorily with the latter class will also rid the liquor of the insoluble particles. The difference lies in the fact that, whereas many standard filtration plants will hold back even the finest material and will provide an optically clear filtrate, most of these systems intensify the contamination of the electrolyte by soluble impurities, because the particles are collected and held under conditions that promote rapid solution.

A suitable grade of diatomaceous earth or other filter aid will enable an optically clear filtrate to be obtained with simple and robust filter plant. The solids found in solutions drawn from electrodeposition vats contain a proportion of compressible slimes that build up to form a non-porous sludge unless the cake is kept open by a filter aid. These slimes are very fine and are exceedingly difficult to remove if they are allowed to be carried by the liquor into the pores of a filter candle. The particles of filter aid are comparatively large, and the cake of filter aid and dirt will drop

off the surface of the candle when moderate back pressure is applied. If pinholing of the candle occurs the filter aid will prevent unfiltered liquor passing through the pinholes. In fact, the material of the candle should be regarded as a support for the filter aid which is itself the filter medium. The quantity of filter aid used depends upon the quantity of slimes, but no advantage is to be obtained by using more than the minimum to secure satisfactory results. Facilities for pre-coating the surface of the candles with filter aid distributed in clean water are an unnecessary complication in this class of work. Diatomaceous earth is entirely inert in electro-deposition solution, and, if necessary, may be added to the liquor in the cells without any detrimental effect.

It is sound practice in most filtration problems to design for a large area of filter medium in order that the filter may be worked for long periods without shutting down to remove the cake or sludge. Filter presses fulfil this requirement. But in dealing with electrolytes the conditions are entirely different. The proportion of solids is so small that even a small surface area of filter medium will retain the sludge without building up excessive pressure for a longer period than is desirable if the risk of contamination by solution is to be avoided. A vacuum-operated rotary-filter works on the right principle, but this type does not lend itself to use with corrosive liquors or where the proportion of solids is very low. The objects to be aimed at are an optically clear filtrate and facility for frequent removal of sludge with minimum loss of liquor. As is the case with every item of plant that has to work with corrosive liquors extreme simplicity of construction is preferable to niceties of mechanical design.

A candle type of filter has been found satisfactory in conjunction with a simple filter pot and a circulation system that allows the introduction of filter aid.

The choice of candle must depend upon the liquor but the grade should not be very fine. Very fine grades are too fragile and usually have a surface that is too smooth to hold the filter aid. The form of candle can be a plain cylinder open at both ends and about 2½ in. outside diameter. Such candles are cheap and obtainable in many materials and grades. The candles can be mounted below the filter plate by a drilled rod of stainless steel or other suitable corrosion-resistant alloy which passes through the plate and the candle, and is threaded externally at both ends to take washers and nuts of the same material. The joints between each candle and the underside of the plate at the top and between the candle and the metal washer at the bottom can be made by soft moulded rubber washers. If wing nuts are used at the bottom, the fixing can be done without tools, and the risk of over tightening and cracking a candle is avoided. This type of construction ensures that the candles are held in compression so that considerable back pressure can be used for washing, and also supports the lower ends

of the candles and avoids fractures due to vibration. Any candle can be removed for examination in a few minutes.

The filter pot should be as small as possible and the candles close together to reduce the free liquor space, but the inlet, which should be at the bottom, should be baffled or so arranged that the turbulence of the incoming liquor does not disturb the layer of filter aid and sludge accumulated on the candles. For the same reason the plant should be substantially mounted to avoid vibration.

Granulated Superphosphate.—A new process for producing granulated superphosphate or compound fertilisers has been developed by the Davison Chemical Corporation at their Curtis Bay plant and is described in *Chem. Metall. Engng.*, 1940, **47**, No. 1, 4-9, and No. 2, 102-105.

In the first stage of the process fresh superphosphate is mixed with 10 to 20 per cent. of classifier dust to reduce the moisture content, which is then accurately adjusted by spraying the material with water in a rotary conditioning chamber. This operation is visually controlled and has to be carried out by an experienced workman.

The conditioned material then passes, for the second stage, through a water-jacketed chute into the furnace end of the dryer, which consists of a rotating cylinder about 8 ft. in diameter and 50 ft. long, where granulation takes place. The granulated superphosphate is discharged either on to a conveyor belt which carries it straight to storage, or into a pit from which it is craned into stock piles. It is stored for a minimum of ten days, and acidulation is carried to 95 per cent. completion, producing a flat 20 per cent. superphosphate.

The following analyses indicate the changes which take place in the stages of the process.

	From Den. *Per cent.*	From Granulation. *Per cent.*	Shipments. *Per cent.*
Moisture	10·56	5·15	1·67
Total P_2O_5	20·03	21·08	21·44
Insoluble P_2O_5	3·04	2·75	1·18
Available P_2O_5	16·99	18·33	20·26
Extent of Conversion	84·7	87·0	94·5

The process for the granulation of mixed fertilisers is essentially the same as that for the treatment of superphosphate.

An interesting aspect of the company's operations is the manufacture of fluorine by-products. During the reaction between the phosphate rock and sulphuric acid, hydrofluoric acid is given off and reacts with silicates evolving silicon tetrafluoride which is drawn off by the ventilating ducts and is dissolved in water to free hydrofluosilicic acid from which salts are manufactured.

Ammonium, sodium and zinc silicofluorides are used in the laundry industry, the ammonium salt is also used as a moth-proofing

agent, and the sodium salt in glasses and enamels, and as an insecticide. Solutions of magnesium and zinc silicofluorides are used in hardening and water-proofing concrete surfaces and as priming coats on newly plastered walls, while the magnesium salt is also used in the wood-pulp industry. Hydrofluosilicic acid is itself used to some extent as an electrolyte and disinfectant.

Pozzolanas and Lime-Pozzolana Mixes.—The addition of pozzolanic materials to Portland-cement concrete mixes for work underground, or in water, or where an increased resistance of the concrete to chemical attack is desired, has become common practice in continental Europe. The possibility of using such material as a substitute for Portland cement also merits consideration in localities where lime and pozzolana are available, and the cost of imported Portland cement is prohibitive. In this BULLETIN (1939, **37**, 434-440) an account was given of the preparation, from a Fijian clay, of an artificial pozzolana which gave a product of excellent strength when used in admixture with lime prepared from local coral.

Scientific data on the comparative properties of natural and artificial pozzolanas, and on methods of testing these materials, have not been readily available, and in 1928 an investigation into these matters was started at the Building Research Station, in co-operation with the Associated Portland Cement Manufacturers, Ltd., the Anglo-Persian Oil Co., Ltd., the Dunstable Portland Cement Co., Ltd., and Imperial Chemical Industries, Ltd. This research continued for five years, and was subsequently pursued on a smaller scale by the Building Research Station. The results are now published in *Building Research Technical Paper No. 27*, entitled "Investigations on Pozzolanas: (1) Pozzolanas and Lime-Pozzolana Mixes," by F. M. Lea, D.Sc., F.I.C. A further report will deal with mixtures of Portland cement and pozzolanas.

It has been found in the course of the investigation that measurements of the rate of reaction of pozzolanas with a lime solution, or of the amount of lime becoming combined with a pozzolana in pozzolana-lime mortars, do not, in general, afford any indication of the strength developed in pozzolana-lime mortars. An accelerated strength test has, however, been devised for pozzolana-lime mixtures, and it has been found that the strength of a plastic mortar, cured for 7 days in moist air at 18° C., and then for 46 hours in water at 50° C., and 2 hours in water at 18° C., gives an estimate of that developed in 90 days at ordinary temperatures.

Factors influencing the strength of lime-pozzolana mortars have been investigated, and the effects of gypsum, fineness of grinding, temperature, etc., are discussed. The strengths developed by the good artificial pozzolanas are shown to equal those given by the natural products, which all give similar strengths at long ages. The well-known Santorin earth develops strength only slowly, and

is probably more suitable for use in Mediterranean regions, where higher average temperatures prevail, and development of strength consequently takes place more rapidly than in this country.

Standard tests for pozzolanas to be used in lime mixes are considered, and it is stated that in general the only tests required for pozzolanas for use in pozzolana-lime mixes are (1) fineness, (2) soluble salts and total acid-soluble sulphur trioxide content, and (3) strength developed in lime mortars.

The effect of soluble salts in pozzolanas, from the point of view of the possible production of efflorescences, has also been investigated. A suggested specification for hydrated lime, for use in testing pozzolanas, is given in an appendix.

The Infrasizer and Superpanner.—In a recent short paper (*Bull. Instn. Min. Metall., Lond.*, No. 431, August 1940) Dr. W. R. Jones describes the Infrasizer and the Superpanner, which were invented by Dr. H. E. T. Haultain, lately Professor of Mining Engineering in the University of Toronto.

The *Infrasizer* is a mechanised air elutriator by means of which material, such as ore ground to minus 200 mesh, can be split into seven fractions, the finest grain size being less than 10 microns, and, under certain conditions, even less than 5 microns. The latest model consists of six tubes, five conical and one cylindrical, and a bag at the air exit to catch the finest particles. The diameters of the tubes vary as the square root of two which results in the average diameter of the different fractions varying in the same ratio.

The tendency for the fine particles to adhere to each other is overcome by a cone and ball device at the entry ends of the sorting columns. The air-borne particles impinge on the ball and pass between it and its rubber seat. The ball rotates and wobbles continuously, thus freeing the particles from each other. The tubes are raised about one-eighth of an inch and dropped about 80 times a minute, and are also tapped towards the end of the operation to free any material clinging to the inner surfaces.

The results obtained are excellent, giving accurate sizing in quantities of 8 to 20 assay tons.

The *Superpanner* is a sort of mechanised "vanning shovel" combined with various other similar instruments for separating minerals of different specific gravities. It consists of a specially shaped pan and a mechanism easily capable of a number of adjustments while in operation. The pan narrows gradually towards the end where the heavier minerals become concentrated and has a rustless metallic surface. The bottom is bent with a gradually decreasing radius of curvature. The following adjustments may be made: the slope of the pan; the intensity of the end bump; the length of stroke accompanying the bump; the number of strokes per minute; the amplitude of the side shake separately for each end of the pan; the number of oscillations per

minute; the amount of wash water; and the depth of the water pool at the deeper end of the pan.

The end bump moves the material forward; the water, aided by the side motion, washes the lighter particles towards the rear or deeper end of the pan, and the heavier minerals become concentrated as a triangular patch ending in a fine tip of the heaviest minerals. The concentrates are collected by a small specially shaped pipette.

The tailings and overflow are removed through a suction tube at the deeper end of the pan and are collected.

The mechanism is operated by two independent motors, one operating the end bump, the other the side motion. Material from 65 mesh to 14 microns, or even finer if the infrasizer is used first, may be treated. In Canada the superpanner is used for the recovery of minute quantities of gold or gold tellurides, for the separation of pyrite from free gold and gold tellurides, of gangue from sulphides, and for testing tailings. In Portugal it is used to estimate the wolfram content of mill feed and tailings and is stated to give results accurate to within 0·5 per cent.

BOOK REVIEWS

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

STRATEGIC MINERAL SUPPLIES. By G. A. Roush. Pp. xvii+485, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1939.) Price 33*s*.

Strategic raw materials, as currently defined, are those commodities which are essential to a nation's military and industrial requirements, but in which that nation is definitely deficient from a domestic point of view and must consequently seek supplies from outside her own borders. The procurement of such materials or "deficiency commodities" is obviously a matter of prime national importance that cannot be too strongly emphasized at the present time, when countries are profoundly affected by war policies and self-sufficiency is placed at a premium.

American experts have long appreciated this point of view, and during the past two or three decades many interesting and valuable works have been published dealing primarily with those materials, especially minerals and metals, in which the United States is deficient. The latest of these excellent publications, now under review, is by the well-known editor of *The Mineral Industry*, Major G. A. Roush, of the Staff Specialist Reserve, United States Army. In 1934 he published in *The Military Engineer* a series of articles on the various strategic minerals and metals of the United States which earned for him the Toulmin Medal for 1938, awarded by the Society of American Military Engineers. These articles form the basis of the present work, which, as the author points out, is not

concerned with the possession of mineral supplies as a *casus belli*, or even with their use as a weapon of offence, but rather as an item in a programme of defence and in the regular course of industrial utilisation. Twelve commodities, viz., manganese, nickel, chromium, tungsten, tin, aluminium, antimony, mercury, platinum, mica, iodine and nitrogen, are discussed in considerable detail, each being treated under the following heads: U.S. requirements, uses, substitutes, ores, ore reserves, world output and supply, U.S. output and supply, utilisation, prices, tariff, political and commercial control, general review of domestic situation and conclusion.

In general a policy is advocated of stock-piling reserves sufficient for tiding over America's anticipated needs for a period of one or two years. In the case of manganese, a stock of at least 700,000 tons of ore is given as the "irreducible minimum." The varying degrees of American self-sufficiency in the more important strategic commodities during the 25-year period 1913 to 1937 are indicated in the following table:

U.S. SELF-SUFFICIENCY RATIOS FOR STRATEGIC MINERALS

	Pre-war (1913.)	War Peak.	Pre-depression Peak.	Post-depression Peak.	Period Average.
1. Tin	0·1	0·1	0·1	0·2	0·1
Nickel	3	1	4	0·2	1
2. Chromium	0·5	45	0·3	0·4	4
Manganese	1	36	12	4	8
3. Antimony	22	14	19	9	17
Mica	43	37	31	16	26
Bauxite	91	105	67	64	75
Aluminium	66	121	91	89	75
4. Tungsten	42	70	40	37	36
Mercury	95	118	122	47	63
5. Platinum	1	15	5	11	6
Iodine	—	—	—	13	19*
Nitrogen	24	18	66	84	51

* *Average since* 1932, *when production was first reported.*

From inspection of the above self-sufficiency ratios, the U.S. strategic minerals can readily be divided into five groups, differentiated as follows:

Group 1.—Those for which the self-sufficiency ratio is practically zero, with no prospect for improvement; this group includes tin and nickel.

Group 2.—Those for which the self-sufficiency ratio is normally very low, but which are subject to a marked improvement, under emergency demand; this group includes chromium and manganese.

Group 3.—Those with a moderate degree of self-sufficiency under ordinary conditions, but with little prospect for marked improvement under emergency demand; this group includes antimony, mica, bauxite and aluminium.

Group 4.—Those with a moderate degree of self-sufficiency under ordinary conditions, and a possibility for material improvement under emergency demand; this group includes tungsten and mercury.

Group 5.—Those for which a safe margin of reserve supply or a high degree of self-sufficiency has been developed and which have consequently been removed from the official list of the U.S. War Department; this group includes platinum, iodine and nitrogen.

It is, of course, impossible to summarise adequately and briefly the mass of pertinent information in this outstanding work. To those whose duty it is to study the strategy of minerals it is stimulating and thought-provoking; to those who seek factual data on the commodities dealt with, it is a veritable *vade-mecum*.

PRINCIPLES OF ECONOMIC GEOLOGY. By William Harvey Emmons, Ph.D. Pp. xix + 529, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1940.) Price 26*s*.

During the twenty-two years which have elapsed since the first publication of this well-known text-book on mineral deposits, so much progress has been made in the subject that the author has deemed it advisable to re-write the whole of the original text, at the same time adding numerous illustrations, increasing their number to well over 300. The result is a useful, up-to-date and comprehensive treatise on metalliferous and non-metalliferous deposits of all types, excluding fuels, for advanced students both of geology and mining engineering.

As in the first edition, the present text is divided into two parts: (1) a general statement on the subject, including discussions on genesis, enrichment and structural control of mineral deposits from a generic point of view, and (2) a detailed statement on specific metals and non-metals. The first part comprises rather less than half the book and forms Chapters 1 to 16: the second part comprises eight chapters devoted to iron; copper; gold and silver; zinc and lead; nickel, platinum and chromium; tin and tungsten; miscellaneous metals (including mercury, antimony, aluminium, manganese, molybdenum, arsenic, bismuth, cobalt, cadmium, selenium and tellurium, radium and uranium, vanadium, titanium, tantalum and columbium, zirconium and beryllium); and deposits of non-metals. The section on the last-named subject occupies 39 pages and deals with more than 40 commodities ranging from building stones to artesian water.

The book is primarily designed for American students and the author has drawn most of his examples from North America. Unfortunately the student may be misled by a number of minor inaccuracies in the text (particularly in the last two chapters), or by the omission or curt dismissal of data regarding sources of minerals outside the United States.

SEDIMENTARY PETROGRAPHY. By Henry B. Milner, M.A., D.I.C., F.Inst.Pet., P.A.Inst.W.E., F.C.S., F.G.S. Third Edition.

Pp. xxiii + 666, 8½ × 5½. (London: Thomas Murby & Co., 1940.) Price 45s.

The third edition of this well-known work on sedimentary petrography is especially welcome at the present time, as the previous edition (reviewed in this BULLETIN, 1929, **27**, 538-539) has been out of print for well on six years. The work has now been entirely reset, revised and substantially enlarged, the pages being increased from crown 8vo to demy 8vo.

Apart from additional data in the sections on descriptive mineralogy and petrology of the sedimentary rocks, the mechanical constitution and study of fine sediments receive treatment in the light of current knowledge. The section on laboratory technique is expanded to no less than six chapters, covering mechanical analysis, mineral concentration, X-ray, spectrum, fluorescence, micro-chemical, microscopical and other methods of approach to practical problems presented by all types of sedimentary raw materials.

In addition to the specialised applications of the subject to stratigraphical correlation (particularly in its bearing on petroleum technology) several other economic applications are now briefly described with reference to building and highway construction, forensic science, industrial maladies (e.g. silicosis, asbestosis) and water supply, as well as to the asphalt, ceramic, glass and refractory industries.

The work will no doubt remain the standard text-book for students for some time to come. One feels, however, that the many pitfalls of the science are not sufficiently emphasised in a work of this sort, and that various sections devoted to subjects more adequately and appropriately treated elsewhere, could have been omitted with advantage.

GEMSTONES. By G. F. Herbert Smith. Ninth Edition, Re-written. Pp. xvii + 443, 8½ × 5½. (London: Methuen & Co., Ltd., 1940.) Price 18s.

The wide and sustained popularity of Dr. Herbert Smith's book on gemstones is attested by the appearance of seven reprints within twenty-five years.

The present volume, however, is not a reprint but an entirely rewritten edition in which, although the format follows rather closely that adopted in the previous editions, the text has been greatly expanded and the photographs and diagrams greatly improved. Taken by and large the new volume provides one of the best English texts on the fascinating subject of gemstones.

Part I, in particular, which deals with physical characters, has been considerably improved by the incorporation of much more up-to-date information. Two new chapters have been added to Part II, which deals with technology and history, one covering geographical distribution and prices, and the other bible stones,

but the first of these is rather weak inasmuch as the first page or so has nothing to do with the subject discussed and the tables of percentage production are taken from data published in 1922.

Part III, which deals with descriptions of the individual stones, their mode of occurrence and the deposits in which they occur throughout the world, has been greatly enlarged and brought up to date. It provides as good an account of all types of gemstones as can be found anywhere. In common with most writers on this subject the author touches upon the industrial uses of diamond without making any mention whatever of the industrial uses of other stones also used as gems, e.g. corundum, garnet, zircon, quartz, etc., and here we find a few mis-statements. Thus, on p. 195, we have " No measurements have been made of the hardness of diamond," whereas actually, among others, C. E. Wooddell, in the United States has carried out a considerable amount of work on this point (*J. Electrochem. Soc.* 1935, **68**, 111-130). On the same page we have " the metal tantalum and the artificial product, carborundum (silicon carbide) have a hardness which is comparable with that of diamond." Presumably the author had tantalum carbide in mind, but it is strange that he should have omitted any mention of boron carbide, which is even harder and is largely employed on this account in certain countries. In the same chapter the remarks concerning the industrial uses of diamond are confusing and no reference is made to the extensive use of boart either in truing abrasive wheels or in rock-drilling.

Part IV, which is very brief, deals with identification and contains several useful tables of gemstones arranged according to their various physical properties. The volume concludes with seven pages of bibliography.

The new edition is well illustrated by means of clear diagrams and good photographs, not to mention a new set of coloured drawings executed by Miss Helen Wilson. The numerous plates, however, have been evenly distributed through the text and are therefore often widely separated from the descriptive matter they illustrate.

In his preface the author, with unusual candour, expresses the hope that, " in its new form, the book will be found even more useful, interesting and *profitable* than it has been in the past." One may trust that despite the considerably increased price he may not be disappointed.

WHAT IS STEEL ? By Leopold Scheer. Third Revised Edition. Translated from the German by F. L. Meyenberg. Pp. xiv + 164, $8\frac{1}{2} \times 5\frac{1}{2}$. (London : Macdonald & Evans, 1939.) Price 6*s*.

This unusual little book is an English translation of one written in German by a Düsseldorf steel merchant to explain the nature of iron and steel to the many non-technical men in the steel trade, who, although anxious to understand the materials they handle, can make little progress with the ordinary text books. The subject

is a difficult one, and the author, quite rightly, has not attempted to conceal this fact, but by starting from fundamentals and explaining each step in concise but simple language he has produced a very sound introduction to the subject.

Starting with a careful explanation of the iron-carbon phase diagram, the author proceeds to apply this to a discussion of the heat treatment of steel. There follows a series of brief chapters dealing with the effects of the various alloying elements on the structure and uses of steels, and separate sections on the stainless and heat-resisting steels, high speed tool steels, and (although not strictly steels) the cutting metals such as stellites and cemented carbides. Finally there is a section on structural defects and the mechanical testing of steel. A chapter on the production of iron and steel in the blast furnace and the steelworks has been added in this third edition, which although outside the scope of the title, certainly adds to the interest of the book.

It would naturally be easy to criticise points of detail in any book of this sort for the author has covered a very wide field in a very small text, but as a whole the subject is admirably treated. Technical terms have not been avoided, but they are explained well and concisely and by frequent use are made familiar. Some of the chapters, however, are unnecessarily brief, and here and there the author has lapsed into short sentences in the style of a note-book, which does not make for easy reading. It is most unfortunate too that the translator has given a far too literal rendering of the original German so that the wording is often strange and the meaning sometimes a little obscure.

Full use has been made of good photographs, diagrams and tables, and this little book serves a useful purpose.

THE CORROSION OF IRON AND STEEL. By J. C. Hudson, D.Sc., D.I.C., A.R.C.S. Pp. xv + 319, 8½ × 5½. (London: Chapman & Hall, Ltd., 1940.) Price 18*s*.

This book is written by the Official Investigator of the Corrosion Committee which is directed conjointly by the Iron and Steel Research Council and the Iron and Steel Institute, and gives a general account of the researches conducted and the results achieved by the Committee since its inception in 1928. Five technical reports have appeared previously but the present volume is intended to present the subject to the general reader. Some idea of the importance of corrosion may be gauged from the cost of protecting iron and steel from rusting by means of protective paints, which is estimated as something of the order of £40,000,000 per annum for Great Britain alone.

The Committee has been chiefly concerned with exploring the possibilities of the production of irons and steels with an increased intrinsic resistance to rusting, and with the development of better methods of protection of finished steel against rusting. The

materials chosen for study comprise twelve types of structural steel, including ordinary mild steel and low alloy steels, an ingot iron, and five wrought irons, each typical of the commercial products they represent. Specimen sheets of these materials have been exposed to corrosion, (*a*) with the rolling scale still adhering to the surface, and (*b*) after removal of the scale by various methods, in each case with and without treatment with protective paints. The large number of trials necessitated by the various combinations of these processes was further multiplied by the fact that complete sets of specimens were tested, as a rule, at four main corrosion stations in Great Britain, and a representative selection at other stations both at home and overseas. Seven of the stations are in Great Britain, the principal ones being at Calshot, Llanwrtyd Wells, Sheffield and Woolwich, and the seven overseas stations are in such varied climates as those obtaining in the Swedish Arctic, Nigeria, Khartoum and Singapore.

This comprehensive plan of investigation appears to have been carried out with commendable thoroughness, and by linking it up with the mass of experience gained from the behaviour of all types of steel-work throughout the country, a wealth of interesting and useful information has been assembled. Separate chapters on these lines deal with the effects of rolling scale, the rusting of unprotected iron and steel in the atmosphere, the prevention of rusting by paints, and protective coatings.

An interesting section deals with rusting in sea water, based on observations on test plates immersed at Gosport, tests on specially treated plates built into two ships, and the inspection of many ships during repairs. Here, in one case, where test plates were built into a naval trawler, the Committee's observations were rendered useless by their failure to appreciate until it was too late that it is the practice in His Majesty's Navy for the ship's crew to maintain all accessible parts of their ship in perfect condition.

The rusting of steel railway sleepers and the rusting of iron and steel in the soil have received special attention as well as other miscellaneous cases of rusting in service.

In addition to this distinctly practical study of corrosion, important laboratory work and fundamental research on theoretical aspects of the subject has been carried out. This includes the important problem of developing a satisfactory accelerated test for resistance to atmospheric corrosion, whereby materials may be tested in a few days or weeks as compared with the much longer periods necessary for field tests. Some hopeful results have been obtained with an apparatus whereby the specimens are subjected to intermittent spraying with very dilute acid solution and drying. With some materials the results obtained during this treatment correspond closely to those obtained in the field tests under natural conditions. Although the main object of the book is to describe the Corrosion Committee's own work, there is also a chapter on

other important researches on corrosion both in Britain and abroad. In conclusion some of the outstanding subjects for corrosion research still to be investigated are listed.

It is a book which should prove useful to all those responsible for the construction and maintenance of steelwork, and one which will stimulate those who appreciate thorough and well co-ordinated research.

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Flint Clays and Flint-Clay Refractories of Southern California. By B. M. Burchfiel and H. Mulryan. *Bull. Amer. Ceram. Soc.*, 1940, **19**, 161-163.

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Mineral Wool. By M. S. Krishnan. *Trans. Min. Geol. Metall. Inst. India*, 1940, **35**, 401-430. The composition, properties and uses of glass wool, slag wool and rock wool.

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EXHIBITION GALLERIES, FILM LIBRARIES AND CINEMA

NOTES

Exhibition Galleries.—The scheme for a restricted opening of the Exhibition Galleries to the public on Saturday and Sunday afternoons has been continued as a war-time measure and has met with sufficient success to justify opening the Galleries on the remaining week-day afternoons. In addition, facilities have been afforded to enquirers, foreign visitors and conducted parties to inspect the collections at any time on application.

For large numbers of the general public the exhibits have acquired a new meaning as a result of the war, and are viewed with a newly awakened or increased interest due to the importance Empire resources have attained by the march of recent events.

On the inception of a separate Burma Court in 1937, Burma gem stones were included in the list of exhibits considered desirable for display in the Court. Burma has long been noted for her gem stones, especially rubies, sapphires and spinels, and has been the principal source of supply of these gems to the world. The exhibiton of cut and uncut gems at the British Empire Exhibition at Wembley Park in 1924 must have achieved a good measure of popularity for, 14 years later, at the Empire Exhibition at Glasgow, many visitors who made enquiries on the subject of Burma gems in general, and of rubies in particular, recalled what they had seen at the Burma Ruby Mines stand at Wembley.

The recent acquisition, through the courtesy of the Government of Burma, Department of Commerce and Industry, of some photographs, negatives and a number of stones, supplemented by photographs kindly donated by U San Win of Mogok, has now rendered possible the display of a fairly complete range of Mogok gem stones, Mogok being the headquarters of the Ruby Mines district.

The exhibit starts with a panoramic view of the town of Mogok nestling in a valley of particular beauty, 4,000 ft. above sea-level, the range of hills to the north and east of the town reaching a height exceeding 7,000 ft. The other photographs show a general view of the mines and also illustrate the various methods of gem-mining employed in Burma. Then there are the gem " gleaners "—women and girls who are allowed by custom, free and without licence, to re-wash and sort the rejected gravels from the mines and to keep

any gem-stone that they may find. Finally, shrewd merchants, who can judge the weight of a stone to a nicety, are shown transacting business at the market place. The exhibit includes a comprehensive range of Burma stones, amongst which are the following specimens: rough, cut, unpolished or polished stones of ruby, sapphire, star sapphire, white sapphire, rose spinel, alexandrite, garnet, topaz, zircon, aquamarine, peridot, quartz, beryl and amethyst.

In the Ceylon Court, a set of old photographs featuring the native races of Ceylon has been withdrawn, and the pilaster thus vacated has been advantageously used to accommodate some large plumbago photographs lately secured from Ceylon House in London prior to its close. These photographs, depicting up-to-date methods of plumbago mining in Ceylon, are appropriately associated with the model of a plumbago mine and the plumbago diorama.

On the other side of the pilaster, adjoining the coconut story showcase, miscellaneous views of Ceylon have been replaced by a series of excellent photographs, received from Ceylon through the good offices of the Director of Commerce and Industry, showing the use of both expellers and hydraulic presses in the modern method of coconut-oil pressing employed in Ceylon.

A further addition to the statuettes of Empire builders is the bronze of General Gordon which has been added to the exhibits in the Sudan Court. This is the work of Mr. Herbert H. Cawood, and portrays Gordon in the dress of Governor General seated on the back of a camel which is furnished with characteristic picturesque trappings.

The cost of the statuette was defrayed out of a special grant for the purpose made by the Sudan Government.

The printed label attached to the pedestal on which the statuette is placed reads as follows:

General Gordon

(1833-1885)

" Charles George Gordon was born at Woolwich on January 28, 1833, and was educated at Taunton School. He entered the R.M.A. Woolwich in 1848 and was commissioned as 2nd Lieutenant in the Royal Engineers in 1852. In 1855 he served in the Crimea at the siege of Sevastopol, and after peace had been declared was attached to the International Commission to demarcate the boundary between Turkey and Russia.

" In 1860 War having broken out in China he was ordered there and was present at the destruction of the Summer Palace at Pekin. He remained in China with the army of occupation and, in 1862, when the Taiping rebellion against the Chinese Government broke out, Gordon, now a major, was given the command of the Government troops known as 'The Ever-Victorious Army,' which he had reorganised. By June 1864 he had subdued the revolt and was

promoted by the Emperor to the rank of 'Titu,' the highest in the army, and received the Yellow Jacket.

"Early in 1874 Gordon accepted service under the Khedive with instructions to check the slave trade in the Sudan. He proceeded to Khartoum and thence up the White Nile to Gondokoro, establishing a line of posts from the Sobat to the Uganda frontier. Owing to lack of support he left the Sudan in 1876 for Egypt and eventually England, but was persuaded by Ismail Pasha to return as Governor-General of the Sudan, and during the next three years he was engaged in reforming the local system of administration.

"In 1880 Gordon resigned this appointment and visited India, China, Mauritius and Basutoland. The unjust and weak rule which followed after he left the Sudan led to the outbreak of revolts, a certain Mahommed Ahmed, regarded as a holy man, having declared himself as the 'Mahdi,' a successor of the prophet. The situation having become critical, the British advised the Khedive to evacuate the Sudan, and Gordon was sent to Khartoum to report on the best method of carrying out the withdrawal. He reached Khartoum on February 18, 1884, when the rebels under the Mahdi were advancing on Khartoum, and by March 18 the seige had begun. Had it not been for Gordon the town would soon have fallen, but he was able to put up a gallant defence which lasted till January 26, 1885, when the Mahdi's troops captured Khartoum by assault and killed Gordon on the steps of the palace.

"The last words of Gordon's last letter are 'I am quite happy, thank God, and, like Lawrence, I have tried to do my duty.'"

To the East Africa Court has been added a number of photographs of livestock and related industries in Kenya; also a series to illustrate the Kenya hide industry. These photographs were received for exhibition from the Director of Veterinary Services, Kabete, the hide industry series having been taken by Mr. J. H. Ward, Instructor in Stock, Sangolo. The types of domestic animals illustrated include sheep and native cattle, a Boran cow, Nandi cows and bulls, and North Kavirondo cows and bulls; the hide industry series shows the result of demonstrations given to natives by Veterinary Scouts in the preparation and drying of hides for export, and shows all stages in modern practice, including the flaying of the animal and the cleansing, stretching, drying, transport, and the arsenical spraying of the hides, and finally their baling for shipment.

Through the generosity of Dr. D. R. Grantham, Geologist, Lands and Mines Department, Tanganyika Territory, an exhibit comprising photographs and specimens has been acquired which illustrates the local method of iron smelting and the fabrication of a native hoe and spearhead. The photographs show (1) the transport of iron-ore as head loads from surface or shallow pits to the site of the blacksmith's hut, which is often distant two or three days journey; (2) the scene of operations—a special hut with heaps of

ore outside; (3) the furnace constructed of slabs of dry anthill earth with walling of broken pottery scraps in between and five funnel-shaped clay pipes (tuyeres) inserted at regular intervals; (4) a pair of bellows hollowed out of a single piece of wood and covered with soft goat skin, operated by sticks tied in the centre of each skin; (5) native artisans using a stone hammer to shape the metal on an anvil of granite.

The specimens comprise (1) a sample of iron-ore; (2) the product of the first smelt—a spongy mass of metallic iron with pieces of charcoal; (3) the product of the second smelt, and (4) a sample of the slag; (5) a lump of iron, the result of re-heating and hammering the product of the second smelt; (6) and (7) stages in the fabrication of a hoe; (8) and (9) stages in the making of a spearhead. This material has been arranged in a wall-case as a story exhibit in the East Africa Court, the photographs and specimen being connected by guide lines to show the sequence of events from the raw material to the finished article.

To the Canadian Court has been added an exhibit which is of interest not only from a topical standpoint but also because it illustrates the manner in which two important Empire industries are frequently wedded to produce a third one. It is the story of aluminium manufacture, and the head label reads:

" Canadian Aluminium flows from the union of British Guiana's 'White Earth' and Canada's 'White Water.'" It is a natural corollary to the bauxite exhibit shown in the British Guiana Court.

Starting with a sample of bauxite (the "White Earth") from British Guiana, the Empire's principal source of this ore of aluminium, the story first traces its purification to pure alumina. It then proceeds to show how part of Canada's abundant hydro-electric resources ("White Water") is employed to unlock from the alumina the metallic aluminium which is in such demand at the present time. The essential part which an abundant supply of cheap electricity plays in aluminium manufacture is brought home to the visitor by the statement that to make one pound of the metal requires an amount of current that would keep a 40-watt lamp burning continuously for 12½ days. This section of the story is completed by a full-sized ingot of aluminium, the form in which the bulk of Canadian aluminium is exported for further manufacture. The remainder of the exhibit is devoted to examples of Canadian aluminium manufactures which range from the more technical rolling mill products, die castings, stampings and spinnings to such domestic utilities as cooking utensils, hair curlers and wave clips.

The reorganisation of the Cyprus Court has been continued and story exhibits have been prepared so far as the material received from the Cyprus Government permits covering the following industries: the citrus industry; viticulture, wine-making and sultana drying; the tobacco industry; olive culture and olive oil-making;

as well as the important copper and asbestos mining industries. Further material to complete these displays has been promised, and this will doubtless be forthcoming when the difficulties which the colony is now facing have passed away.

In the New Zealand Court the rabbit-fur exhibit has been re-arranged in the form of two distinct story displays, one on either side of a partitioned showcase. One illustrates the making of men's felt hats from rabbit fur, and the other the use of rabbit skins for the production of imitation expensive furs. The first story has for introduction a toy rabbit sitting in an inverted top-hat, with the legend " Rabbit into Hat—Conjurors can produce rabbits from hats. To turn a rabbit into a hat is a more difficult task. Yet it is done every day by hat-manufacturers." Then follow specimens and photographs illustrating the successive stages in the production of a soft-grey and a hard black fur felt hat: the preliminary treatment of the skin; the good quality fur cut from the back of the rabbit; the winnowing of the fur to get rid of the non-felting hairs (kemps) and skin pieces (dags); the forming of a large " hood " on a cone of wire gauze by air suction; the shrinking of the hood by treatment with hot water and sulphuric acid and by pressure; the infiltration of shellac for proofing and stiffening; the dyeing, the stretching and blocking to shape, the shaving with sandpaper, the brim curling and finally the trimming.

The second story starts with a skin folded with the fur inwards as received from New Zealand. Other specimens show the skin opened out, and the " pulled " skin (the coarse hair-tips pulled off). From this last specimen a number of arrows radiate out to dyed skins and sheared and dyed skins that have been made to imitate more expensive skins such as mole, seal, sable and beaver, for the production of cheap fur coats and coat trimmings.

Sixty photographs of New Zealand scenes have been enlarged and mounted and arranged in two sets of swing frames to form pictorial travelogues, one touring the North Island and the other the South Island. The photographs illustrate in the course of the tours, the chief cities and towns with the loading for export of important products such as chilled beef and wool, typical sheep stations, dairy farms and pastoral and agricultural scenes, fruit orchards, the hot springs of Rotorua, and the beauty of the alpine and fiord scenery. With each set of photographs is displayed a map numbered to correspond with numbers on the photographs so enabling the visitor to locate each scene on the map.

In the Papua and New Guinea Court an exhibit of coloured and illuminated transparencies illustrating gold-mining activities in New Guinea has been arranged, the transparencies having been presented by Mr. C. A. Banks of Bulolo Dredging, Ltd., together with a sample of the gold-bearing gravel and of the gold dust recovered from it. These samples are shown with the transparencies in one of the six illuminated panels of the wall-fitting specially constructed in the

Imperial Institute workshop. The illuminated head label for this exhibit reads as follows:

Mining Gold by Aeroplane, Dredge and Monitor.

" With the aid of the aeroplane heavy mining equipment has been conveyed from the coast over 35 miles of difficult country to work the rich alluvial gold deposits in the mountainous interior."

Photographs have been lent from the Australian Court to serve as illustrations in a volume entitled " The British Commonwealth in Pictures " which has been planned with the advice and approval of the Foreign Office and the British Council, for distribution in the British Empire, the United States of America and the chief allied and neutral countries. Other photographs from the Collections have been lent for the use of the National Council for British Commercial Propaganda Overseas.

Among the distinguished visitors who came to the Exhibition Galleries by arrangement with the Director during hours when the Galleries have been closed to the general public were Mr. Harcourt Johnstone, M.P., Secretary to the Department of Overseas Trade and President of the Board of Governors of the Imperial Institute; Mr. S. F. Waterson, High Commissioner in London for the Union of South Africa, with Mr. F. J. du Toit, Official Secretary; Lt.-Col. G. R. Harding, D.S.O., newly-appointed member of the Board of Governors of the Imperial Institute representing the Association of British Chambers of Commerce; and Sir Frank Stockdale, K.C.M.G., C.B.E., Comptroller for Development and Welfare in the West Indies.

Empire and G.P.O. Film Libraries.—Since the last notes relating to the Libraries appeared in this BULLETIN, 1940, **38**, 137, the number of new prints added to the Libraries has amounted to 121. Of these, 87 relate to subjects which have already appeared in the catalogue. The remaining 34 prints cover 16 new subjects and deal with various parts of the Commonwealth.

Considerable difficulty is experienced in securing an adequate supply of prints of silent films which still account for the greater part of the demands made on the Library. Little or no new silent material is being issued and the copies of old Empire Marketing Board films are rapidly wearing out and need replacing. In the years 1938 and 1939 the Imperial Relations Trustees made generous grants in order to meet the requirements of the Empire Film Library in this direction, and the Trustees recently decided to make a further grant of £500 which will enable the Library to replenish its stock of silent films of the Empire.

Of the new films one, entitled " Transport," is of general Empire interest; another, " Country Currents," deals with the United Kingdom, and a third, " A Nation is Built," with Australia. Two of the new films, " Animal Life " and " African Skyways," are concerned with South Africa and ten of them with Canada. These

are " Heritage," " From Gold Ore to Bullion," " Quebec," "Ottawa," " The Royal Visit to Canada," " Top of the World," " The Evergreen Isle," " Canadian Mountain Majesty," " Quebec and the Maritimes," " Happy Hunting Ground." India is represented by one new film, " City of Madras."

During the first six months of 1940 the number of films circulated by the Libraries amounted to 24,632, as compared with 22,646 for the corresponding period of 1939.

Empire Lantern Slide Library.—In the process of revising and expanding the Empire Lantern Slide Library 1,300 new slides have been purchased with the grant made by the Colonial Empire Marketing Board.

The following Picture Talks have been written, and printed for circulation with the appropriate sets of slides:

A Visit to India . . .	By C. F. Strickland, C.I.E., I.C.S. (Retired)
The North West Frontier .	Do.
Rural and Urban Life in India	Do.
Government in India . .	Do.
A Visit to Burma . . .	By M. Myat Tun, B.Sc. (Econ.).
A Lantern Lecture on Burma .	Do.
Gibraltar, Malta and Cyprus .	By A. J. Findlay, C.M.G., Colonial Agricultural Service (Retired).
Gambia and Sierra Leone .	Do.
Nigeria	Do.
Gold Coast	Do.
Kenya	Do.
Uganda	Do.
Zanzibar and Tanganyika .	Do.
Nyasaland and Northern Rhodesia	Do.
Aden, Somaliland, Seychelles and Mauritius . . .	Do.
Spices of the Colonial Empire .	Do.
Fresh Fruits of the Colonial Empire	Do.
Vegetable Oils of the Colonial Empire	Do.

The following presentations have been received:

The High Commissioner for the Union of South Africa, 150 slides of South Africa.

The Board of Education, 500 slides of India.

Messrs. Imperial Airways Ltd., 600 slides on Empire Air Routes.

The British Rubber Publicity Association, 50 slides on the Preparation of Plantation Rubber.

Dr. D. G. Grantham, 85 slides of British Guiana, 130 slides of Tanganyika.

The High Commissioner for Australia has loaned for the duration of the war 8,000 slides of Australia.

Colonial Visitors.—The following is a list of officers on leave from the Colonies, etc., who have visited the Institute during the three months May, June and July 1940.

MAY

W. G. BEATON, Deputy Director, Veterinary Services, Nigeria.
E. L. G. CLEGG, Superintending Geologist, Geological Survey, Burma.
L. W. G. ECCLES, M.C., Commissioner for Lands, Mines and Surveys (Local Government), Northern Rhodesia.
A. S. McKINNON, Agricultural Officer, Somaliland.
J. RALSTON, Senior Inspector of Schools, Hong Kong.
G. M. RODDAN, Agricultural Officer, Sierra Leone.
E. McL. WATSON, Marketing Officer, Nigeria.

JUNE

H. C. M. AUSTEN, C.B.E., General Manager, Mauritius Railways.
F. E. BUCKLEY, Agricultural Officer, Nigeria.
G. S. COTTERELL, Senior Specialist, Laboratory Staff, Agricultural Department, Gold Coast.
J. CRAIG, late Financial Secretary and Colonial Treasurer, Fiji.
E. I. NISBETT, Agricultural Officer, Sierra Leone.
Captain H. G. POYNTER, Senior Agricultural Officer, Nigeria.
A. J. WAKEFIELD, Inspector-General of Agriculture, West Indies.
Captain N. A. C. WEIR, District Commissioner, Sierra Leone.

JULY

H. R. R. BLOOD, C.M.G., Colonial Secretary, Sierra Leone.
J. V. R. BROWN, Agricultural Officer, Tanganyika Territory.
J. H. C. HICKS, Sleeping Sickness Control Officer, Nigeria.
T. W. HUSSEY, Assistant Conservator of Forests, Nigeria.
F. B. LEECH, Veterinary Department, Nyasaland.
K. R. MACDONALD, Assistant Conservator of Forests, Nigeria.
M. NUROCK, O.B.E., Assistant Chief Secretary, Uganda.

All Dominion and Colonial Officers, as well as private residents overseas, who may be visiting London, are cordially invited to come to the Institute to see our Exhibition Galleries and to discuss scientific and technical problems in which they may be interested.

BULLETIN
OF THE IMPERIAL INSTITUTE

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PLANT AND ANIMAL PRODUCTS

ARTICLE

TUNG OIL IN CYPRUS

By S. G. Willimott, Ph.D. (Cantab.), B.Sc.
Assistant Government Analyst, Straits Settlements[1]

One of the most important duties undertaken by the Tung Oil Sub-Committee, appointed more than a decade ago by the Imperial Institute Advisory Committee on Oils and Oilseeds, was the distribution of seed and the dissemination of knowledge to suitable territories within the Empire. As a result of these activities Cyprus, in common with other likely Colonies, received a selection of tung oil seeds (*Aleurites fordii*) from the Royal Botanic Gardens, Kew, in 1928 and again in 1929. Species of *Aleurites* are of course not indigenous to Cyprus or the Mediterranean littoral, and there is no mention of them in Holmboe's classical work [1].

The seed so obtained was distributed by the Conservator of Forests to the different nurseries and plantations of the forest stations of the Nicosia, Troodos, Paphos and Karpass areas. These selected localities included most types of country to be found in the island, i.e. mountain and valley, seacoast and plain. Still further consignments of the seed (*A. fordii*) from Formosa (1931) and from Atlantis, Georgia, U.S.A. (1932) were divided between the nursery at Nicosia, capital of the island, and the Mylous plantation, situated in the Kyrenia mountains about 12 miles north of the capital. In

[1] Prior to his appointment in the Straits Settlements, Dr. Willimott was Government Analyst, Division of Research, Medical Department, Cyprus, and for a time in 1935 was Acting Agricultural Chemist in that Colony.

spite of inevitable difficulties and failures some interesting results have been obtained, and in certain favourable localities of the island the prospects of tung oil production appear to be bright. Before attempting any survey of results, however, a brief statement by Jordan [2] of progress up to 1929 may be referred to: "Some twenty-four separate nursery lots were started on the island, but although germination was fairly good (40 to 55 per cent.) the infant death rate was rather high so that after six months only about 50 per cent. of the original plants were alive. This was thought to be due to sowing at the wrong season, and the prospects are now brighter."

Sufficient time has now elapsed since the commencement of the experimental cultivation trials to attempt a survey of the results obtained in Cyprus, both in the field and in the laboratory. It should be recalled that at the time the seed was first received practically no information was available locally as to the best conditions for its sowing and culture. It was therefore not surprising that a good many early failures resulted through ignorance of the proper cultivation and lack of experience of the species, failures which in themselves were not necessarily due to any inherent disability of the tree to establish itself and possibly had little to do with local climatic and soil conditions. It is now clear that the question of the available water-supply is always likely to be the limiting factor in tung oil production in Cyprus in competition with the already well-established citrus industry. Thus, given some irrigation on a modest scale during the hot summer months, it has been demonstrated that tung oil nuts in good yield with oil of excellent quality can be produced. Should future developments satisfy this essential condition and assuming that there is always likely to be a demand for tung oil in the industries of Europe and America, there appears to be no reason why the island should not enjoy the advantage of producing both crops, as is indeed the case in the Szechwan Province of China. The province of Szechwan produces not only a vast quantity of tung oil for export but supports a large orange industry as well; but it must be remembered that there the rainfall is abundant and is well conserved by a centuries-old system of irrigation.

As comparatively little is still known of this island colony it ay be useful to repeat the salient facts of its topography. e area of Cyprus is 3,584 sq. miles and it is the third largest nd of the Mediterranean, being exceeded in area only by Sardinia Sicily. Its greatest length, from west-south-west to east-h-east, is about 140 miles, and its greatest breadth, from north uth, about 60 miles. A narrow tongue of land, known as the ass, some 10 miles in breadth and 45 miles in length, runs in st-north-easterly direction towards the Syrian coast. The ains are the chief topographical feature and consist of two nges, both separate and distinct, in each case with a general

direction from east to west. Of these, by far the most extensive is the Troodos range, which fills up almost the whole of the southern portion of the island, and culminates in Mount Troodos, 6,406 ft. above sea-level. The forests found on this range consist chiefly of pine, with some oak, cedar and arbutus, while the valleys abound with olive, myrtle, cypress, carob, juniper and oleander. The northern limestone range, known as the Kyrenia mountains, forms an unbroken line of peaks along the northern coast. The foot of this range is about 3 miles distant from the coast forming a narrow, well-watered, fertile plain. Between these two ranges lies the great Messaoria plain which occupies the centre of the island, and comprises the chief arable land.

These are the three main natural features of the island. The rivers, if indeed they can be so termed, are little more than mountain torrents bringing down flood water after the winter rains, and there is no permanent stream of any volume. The two largest rivers, the Pedias and the Ialias, both of which traverse the Messaoria plain from west to east, flow only in the winter and are essentially mountain torrents. These flow and sometimes flood the coastal plain (Salamis) after the winter rains, but soon dry up on the approach of summer.

The climate of Cyprus, the key to the wealth and variety of its agricultural products, has been studied in some detail by Bellamy [3] and by Hann [4]. In the absence of any general irrigation scheme the available rainfall is usually the limiting factor in crop production and varies considerably from year to year. "There are periodic years of deficiency," says Oakden [5], "when a shortage of rain may cause considerable loss and suffering owing to the consequent decrease in crop production and the curtailment of supplies for drinking. . . . Rainfall fell considerably below the average in the years 1931-33—these unhappy years formed the driest consecutive three-year period since accurate returns were first kept, i.e. since the British occupation in 1878. It is the recurrence of such periods of drought or semi-drought that constitutes the chief (indeed the only) natural ill from which the island is liable to suffer." Rainfall is heaviest between November and March and practically absent from June to September inclusive (Cf. Table II). During these latter months, however, the dew is considerable and helps to sustain vegetation. There are therefore about 7-8 dry months with 4-5 wet months. Temperatures in Cyprus during the summer are surprisingly high, the maximum recorded for Nicosia being 110° F. (1927) [6]. For comparison the mean annual temperature may be taken as 67° F. Snow lies on the highest points of the Troodos range frequently until June. From this brief account it is seen that the climate of the island is definitely seasonal.

Experimental trials with tung oil have been conducted by the Departments of Forestry and of Agriculture in three main areas representing respectively the Kyrenia mountains, the Troodos

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Experimental trials with tung oil have been conducted by the Departments of Forestry and of Agriculture in three main areas representing respectively the Kyrenia mountains, the Troodos

range and the coastal plain. In Kyrenia the chief trial was made at Mylous Forest Station, situated in the pass from Nicosia. Here a tree first fruited in 1931, three years after planting, but by 1937 only five had survived out of numbers and produced a few fruits. The seeds appeared to be normal and free from disease. In addition, a few isolated tung trees are to be found flourishing in the Agricultural Gardens and in the town of Kyrenia. That the early promise of the Mylous trial was not fulfilled may have been due to the presence of too much lateral shade from the surrounding forest trees by the fact of its enclosed position.

At the Forest Experimental Station at Stavros, Paphos State Forest, considerable work has been carried out, although admittedly with somewhat disappointing results. Moreover, the experience at Stavros, allowing for the fact of its greater elevation (2,600 ft. above sea-level) is fairly typical of the results obtained in other forest stations of the Colony. At this station the mean annual rainfall (10-year average) is 35·74 in.

The seeds (*Aleurites fordii*) were sown in the nursery on May 9, 1928, and germinated on June 10, 1928; by August, 90 per cent. germination was reported with the seedlings healthy and growing well. They remained in the nursery until the end of 1929, i.e. eight months longer than is recommended. In August 1928 there were 36 plants, in October 1929, 33, and by early 1930 only 18, at which time they had been planted out. Planting out was done 4 ft. to 5 ft. apart in deep loamy soil, above a spring in a site where the young trees were again subject to considerable lateral shade from a grove of chestnut and cypress. Of those planted out, 9 died that year, drying off and constricting at the collar. The death of half of them thus improved the spacing, which was still too close. As no disease was observed the heavy mortality was thought to be due to the effect of too deep planting [2]. In the winter of 1930 the young trees suffered considerable damage from the effects of hares stripping the bark down to the cambium. In 1931 one tree flowered but failed to set fruit as only a single female blossom was produced. By 1937 only 8 trees, which seemed to be healthy, and the biggest of which stood about 14 ft. high, had survived. This handful of trees therefore had become well established 9 years after sowing and were flowering in season. The observed yield for the 1936 season was a total of 35 fruits, but four trees failed to produce fruit at all, thus giving an average of 4·4 fruits per tree.

It is perhaps noteworthy that a small parcel of *Aleurites moluccana* (candle-nut tree), received at Stavros in 1931, failed to germinate at all. A similar result was observed in the trials in Palestine at different nurseries with *Aleurites montana* [7]. From the results obtained at Stavros it can only be said that, in spite of unfavourable conditions, the hardier specimens of the tung trees did succeed in establishing themselves at the altitude of 2,600 ft. But it is obvious that before any decision could be made as to its

economic possibilities in the mountainous districts, especially the foothills, it would be necessary to plant out seedlings under the proper conditions on the rocky and sparsely forested areas of the massif.

The most promising plantation of tung trees and the only one approaching a trial on an economic scale is undoubtedly that of Polis, developed by the Department of Agriculture, in 1931. Since the oil examined both by the Imperial Institute and by the Government Laboratory, Cyprus, was derived from this trial plot, as well as such data on yields as are available, it may be useful to consider its history in some detail. The experimental plot lies two miles from the village of Polis-tis-Chrysochou alongside the Paphos road, in the open valley of the Chrysochou river. The plot is on level land with a gentle slope towards the river, its elevation being about 50 ft. and its general aspect north-westerly.

The soil is a light calcareous loam of good depth produced by disintegration of sedimentary and igneous rocks of the surrounding hills and brought down by river and rain. A typical analysis of the soil is given in Table I :

TABLE I

Experimental Tung Oil Plantation, Polis

	Per cent.
Insoluble silica	58·45
Iron oxide + alumina	16·35
Lime	5·20
Magnesia	3·05
Potash	0·09
Soda	0·14
Phosphoric acid	0·18
Sulphuric acid	0·70
Carbonic acid	4·00
Moisture + organic matter, etc.	11·84
Total	100·00

Nitrogen	*per cent.* 0·02
Sodium chloride	*per cent.* 0·01
*p*H	6·8

Mechanical Analysis

	Per cent.
Coarse sand	29·84
Chalk	9·30
Fine sand + silt	30·66
Clay	18·54

Reifenberg and Ewbank [8] have made surveys in Cyprus of some soil profiles over limestone and serpentine, for details of which reference may be made to their investigation.

The summer climate of this locality is hot and damp (May to November), and the winter climate, in common with the coastal belt, milder than inland. At Polis it is just possible to grow, though

not really satisfactorily, fruits such as the banana and pawpaw. Rainfall is scanty as will be seen from Table II, where data for the

TABLE II

Rainfall Data in inches at Polis (Paphos), 1930-1939 [6] (*Altitude* 50 *ft.*)

Year.	1930.	1931.	1932.	1933.	1934.	1935.	1936.	1937.	1938.	1939.
January	4·69	5·52	1·41	2·94	1·90	4·22	1·43	3·46	5·89	4·20
February	2·48	5·34	2·52	1·15	3·98	3·82	4·29	0·35	1·85	2·30
March	2·03	2·60	1·91	1·70	1·28	1·85	1·43	0·72	0·50	3·79
April	1·26	0·10	0·46	0·86	0·42	0·48	0·50	0·85	1·18	—
May	0·28	0·24	0·90	0·32	2·05	—	0·65	0·14	0·50	—
June	—	—	—	—	0·05	—	—	—	—	0·25
July	—	—	—	—	—	—	—	—	—	—
August	—	—	—	—	—	—	—	—	—	—
September	1·69	—	—	0·78	—	0·75	0·12	—	0·45	—
October	0·39	—	0·61	0·02	1·67	2·60	0·94	1·27	1·55	0·12
November	2·06	—	6·15	0·23	1·09	—	2·88	2·39	1·33	3·92
December	4·27	1·12	0·05	2·34	9·61	2·67	8·78	0·55	6·68	3·02
Year	19·15	14·92	14·01	10·34	22·05	16·39	21·02	9·73	19·93	17·60

Greatest rainfall in a single day	4·50 *inches*	
Decennial yearly average	16·51 ,,	
Average rainfall for the whole island	19·9 ,,	(10 years)

decade 1930-39 are summarised, showing the monthly, yearly and decennial average precipitation. The figure for the decennial average yearly rainfall at Polis is somewhat lower than the corresponding figure for the whole island, which approaches 20 in. The prevailing winds during the long hot summer are mostly westerly and north-westerly, and it has been thought that these winds are not favourable to the growth of tung trees. Observation of the trees over several summers did not reveal any obvious adverse effects, and this factor does not appear to be of significance. The fact that the tung tree when once established is very resistant to high summer temperatures and to periods of drought is in line with experience in China where these conditions frequently obtain.

The Polis plantation was planted up (1931) from two-year-old seedlings, the plants being placed 12 ft. apart, and the rows, seven in all, a similar distance. The experimental plot occupied an area of one Government donum (⅓ acre). The plot was unfenced and unprotected except for an irrigation ditch on one side. In spite of this the seedlings and trees do not appear to have suffered from the depredations of goats, of which there are large numbers in the island. Other farm animals have shown no interest in the tung tree or its fruit. Manuring was carried out at the rate of 6 okes (1 oke = 2·8 lb.) of mixed stable manure to each tree (Cf. quantities of fertiliser recommended in the Memorandum of the E.M.B. [10] and in American practice). As regards cultivation, up to 1936 the trees were irrigated every 15 days, commencing from the middle of April to the end of October in each year. The whole of the plot was dug over and basins prepared, approximately 3 ft. by 3 ft., round each tree to collect the available water. There were few failures from the planting out, and the experiment as a whole did well from the start. Fortunately the trees have been free from

insect pests or disease, the only exception being a type of white scale observed to attack the leaves of a few trees. The nematode parasite, which causes root knot and is known to be prevalent in the American plantations, has not so far been encountered in Cyprus. The white scale was controlled by spraying the affected trees with an "Alboleum" solution at the rate of 2 parts disinfectant to 100 parts of water. Some idea of the rate of development of the 42 trees comprising this experimental plot may be gathered from the following data:

TABLE III

Yields from Polis Experimental Plot

(Area of one donum (⅓ acre) planted out in 1931 with two-year-old seedlings.)

Year.	Number of fruits gathered.	Yield of fruit (as gathered).	Yield of seed (54% of fruit).	Yield of oil (21·2% of fruit).	Yield of dried seed per tree.	Irrigation Notes.
		lb. per acre.	*lb. per acre.*	*lb. per acre.*	*lb.*	
1933	32	—	—	—	—	Plantation irrigated in summer
1934	262	50·40	27·2	10·7	0·16	
1935	1,200	229·32	123·8	48·6	1·00	
1936	4,186	798·84	431·4	169·4	3·66	
1937	3,600	687·12	371·0	145·7	3·15	Only half the plantation irrigated
1938	2,804	535·08	288·9	113·4	2·45	No summer irrigation
1939	3,550	677·88	366·1	143·7	3·15	

NOTE.—*The figures given in column two for the number of fruits gathered from* 1937 *onwards, together with the whole of the data in columns three to six are taken from a Report on an Experimental Plantation of Tung Oil Trees, published in the " Cyprus Agricultural Journal."* [11].

From this table it will be seen that the trees showed a satisfactory yearly increase in yield up to their seventh year (1936), when the average number of fruits per tree was 100, yielding on an average 3·66 lb. of dried seed.

The smaller harvests from the year 1937 onwards result from the discontinuance of irrigation, thus confirming the view already expressed that it is the available water-supply that is always likely to be the limiting factor in tung oil production in Cyprus. This was first tested by an experiment undertaken by the Department in 1936, in which the plot was divided into two halves, one half being irrigated once every 15 days from May to October, the other half receiving no irrigation at all, as control. It will be observed that the preceding winter rainfall (Table II) had been satisfactory. All the trees were in blossom by the beginning of April, and when the fruits had ripened by October, somewhat unexpectedly, no noticeable difference could be observed in the two sections. It is possible that in some cases the fruits of the non-irrigated half were perhaps smaller than those of the irrigated, but this was not significant since the yield of fruits and the weight of nuts were not affected by the fact of non-irrigation. This result may appear at first sight contradictory to what has been emphasised, but it is understandable if consideration is given to the fact of the close

proximity and small area of the trial plots and a satisfactory preceding winter rainfall. Under these conditions it is unlikely that the height of the water table in the two halves would be greatly affected. During the summers of 1938 and 1939 the whole experimental plot was given no irrigation, but in spite of this the tung trees have remained healthy although giving considerably lower yields of fruit. It will be interesting to learn whether any yearly increase in yield will be maintained, as shown by the figures given in the table for the 1938 and 1939 crops.

Fruits from the 1936 crop were collected in October as they fell on ripening and were allowed to dry in the sun for about one month. By that time they had developed a dark brown colour and had commenced to split from the base upwards, revealing for the most part five loculi, but in a few cases only four, each locule containing a single seed. They were broadly obovoid, slightly ridged and warty, characters typical of tung nuts. The nuts were free from insect pests. The thin woody shells were carefully removed by hand and the percentage of shell and kernel recorded. The kernels were then finely minced and the contained oil expressed in a small hand-press using high pressure in the laboratory. Under these conditions the press-cake still contained a considerable amount of oil. The figure for the total oil content was determined by extraction with petrol ether (B.P. 60-80° C.) in a Soxhlet apparatus in the ordinary way. The sample of cold-pressed oil was then used for the examination by the standard methods of analysis. The sample was noteworthy for its very pale colour, brightness and clarity. The data on the physical examination of the fruits, nuts and kernel are recorded in Table IV.

TABLE IV

Tung Fruits, Nuts and Kernels

Fruits	
Average weight of whole fruit	*grams* 29·7
Percentage of husk in fruit	46·3
Percentage of nuts in fruit	53·7
Average number of nuts per fruit	4·8
Nuts	
Average weight of nut	*grams* 3·5
Percentage of shell in nut	39·1
Percentage of kernel in nut	60·9
Percentage of oil in nuts as received	37·8
Kernels	
Average weight of whole kernel	*grams* 2·1
Percentage of moisture in kernels	4·9
Percentage of oil in kernels as received	60·2
Oil expressed on a moisture-free basis	63·3

In Table V the analytical constants of the tung oil expressed in Cyprus are compared with those of a sample of Cyprus tung oil examined by the Imperial Institute. Data for comparison are also included of a sample of genuine Chinese tung oil (Hankow) and

samples of tung oil from Kenya and from the American plantations, both examined by the Imperial Institute.

TABLE V

Characters of Tung Oil from Cyprus, compared with those of Tung Oil of Different Origin

	Cyprus.		Hankow, China.	Kenya.[1]	U.S.A.[1]
	Examined in Cyprus.	Examined at Imperial Institute.[1]			
Colour [2] Yellow	Extremely pale and bright	1·7	40·0	2·7	2·7
Red		0·2	4·5	0·2	0·9
Specific gravity at 15·5° C.	0·9413	0·9417	0·9417	0·9410	0·9409
Refractive index at 20° C.	1·5205	1·5208	1·5170[3]	1·5198	1·5192
Acid value	0·5	0·4	5·4	0·7	0·4
Saponification value.	191·6	193·2	193·9	193·5	—
Unsaponifiable matter *per cent.*	0·5	0·5	0·8	0·5	—
Iodine value (Wijs) *per cent.*	167·5	169·0	166·5	167·0	163·8
Insoluble bromide value	nil	—	nil	—	—
Heat test *mins.*	9·5[4, 5]	9·5[6]	11·0[4, 5]	9·5[6]	9·5[6]

1 *Samples examined by Imperial Institute* [12].
2 *In 1 in. cell, Lovibond scale.*
3 *R. I. taken at 25° C.*
4 *Browne's Method.*
5 *Gel obtained was of satisfactory texture.*
6 *Paint Research Station Method.*

The results summarised in Tables IV and V show that the fruits are of normal composition with a satisfactory oil content. The proportion of kernel to husk is normal while the expressed oil was found to be of very pale colour, low acidity, and giving constants normal for the oil of *Aleurites fordii*. The results of the analysis in the Government Laboratory, Cyprus, agree closely with those of the Imperial Institute (Table V). These data show that the oil produced in Cyprus is of excellent quality, equal to that obtained from American plantations or, for example, from the experimental trials in Kenya. The quality of the Cyprus oil was clearly superior to that of the ordinary tung oil of commerce from Hankow, China (Cf. Table V). Manufacturing tests have not been carried out with Cyprus tung oil, but oil of this quality could be expected to give satisfactory results in industry and to command a good market, if available in quantity, in the United Kingdom.

It is perhaps noteworthy that during the course of this work several cases of non-fatal poisoning were encountered amongst villagers living in the locality of the experimental plots, who apparently ate the fruit of the tung tree under the impression that they were apples. The chief symptoms included severe headache, vomiting and diarrhoea, which cleared up after treatment. It has

already been noted that farm animals avoid the plant and the fruit.

From these results it can be concluded that although not indigenous to the Mediterranean, *Aleurites fordii* can be grown satisfactorily in certain areas in Cyprus, provided some irrigation is given. The oil from the Polis plantation was good in yield and quality; the trees themselves have remained practically free from disease. A careful consideration of the climatic factor shows that the rainfall generally is inadequate and, where other conditions are favourable, the limiting factor in prospective tung oil production is the available water-supply. The necessity for irrigation, on however modest a scale, would bring the tung oil crop into competition with the well-established citrus industry. Even for an island of such varied agricultural products as Cyprus this is probably undesirable in the absence of any general system of irrigation. But it is possible that such yields as have been obtained could be increased by controlling the genetical variation in the growth of the tung tree by developing, for example, the "multiple cluster" and other desirable varieties. The results, so far obtained at the forest stations, have not been encouraging, but this may not have been due to an inherent disability of the tree to establish itself. Undoubtedly the possibilities of the crop in Cyprus would be more definite if it could be shown that the tung tree can establish itself on the rocky foothills of the mountain ranges where the rainfall is higher than on the plain or coastal belt and irrigation could be dispensed with. Such localities of the island embrace considerable areas, which being either barren or covered only with scrub, are useless for other crops. Further trials along these lines and utilising the experience now available locally might be justified.

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NOTES

The Oil-Seed Industry of Argentina.—The only oil seed grown on any important scale in Argentina for export is linseed and the country is now the foremost linseed producer in the world. Considerable strides have been made in recent years, however, in the production of seeds yielding edible oils for local consumption, and a survey of the position by the American Commercial Attaché at Buenos Aires has been published in *Foodstuffs Round the World*, September 13, 1940, pp. 7-12, from which the following particulars have been taken.

Linseed is one of Argentina's major agricultural crops. While the largest acreage in over eight years was planted in the current crop year, production according to the latest reports available was the smallest registered in 10 years owing to bad weather conditions in April and May and lower yields because of impoverished soil and disease. The provisional figures for 1939-40 are: area, 3,075,496 hectares; production, 1,014,400 tons. The corresponding figures in 1931-32 were 3,496,550 hectares, 2,262,420 tons. Indications are that the 1940-41 crop may be lower still. The elimination of the normal European markets, which annually accounted for more than half of the Argentine linseed exportation, together with a reported heavy crop in the United States probably causing the remaining world demand to be low, caused farmers to hesitate in regard to planting a large area this year. Nature seems to have settled the matter for them, for heavy and continuous rains during the entire seeding period of June through July have delayed ploughing and sowing to a degree not recorded, it is said, in fifty years, and as a consequence many farmers are said to be letting their land lie fallow.

Only a comparatively small proportion of the linseed produced is consumed locally, the annual output of oil in the last few years being 5,000 to 6,000 tons, and of cake 11,000 to 13,000 tons.

The exports of linseed have fallen in recent years, the totals for 1937, 1938 and 1939 being respectively 1,802,048, 1,265,150 and 1,183,072 tons. The United States has been the most important customer, followed by the Netherlands, France and Belgium. The closing of the latter markets is a serious matter for producers. Great Britain took over the purchases which had been made by the Netherlands, Belgium and France, but holders of linseed are said to be of the opinion that England has sufficient stocks on hand for the moment so that further purchases this year will be light. They are reported, therefore, to be holding present stocks for further developments in the international situation and few offerings are noted in the market. Large quantities allegedly are hedged in the market which sellers are unwilling to repurchase since they cannot sell to Europe and business in actual linseed as well as options is practically non-existent.

With former European markets now closed, unless the United States and Canada or other non-European countries enter the market

strongly, there are grounds for forecasting a carry over of linseed into the 1940-41 season as large as that of the 1937-38 season when 109,000 tons were carried over into 1938-39. Strong demand from the United States is not foreseen in view of that country's reportedly large crop in the current season and the disposition of the Argentine existing surplus added to that which will develop in 1941 from the new crop is a problem which is causing considerable local concern. To convert large quantities into oil as a remedial action would be only to shift the burden of loss to the oil millers, since losses of the latter through inability to dispose of cakes and other by-products in the customary European markets would offset to a large extent their profits from increased production of linseed oil.

There is a small but increasing production of tung nuts in Argentina as increased numbers of trees come to bear each year. Tung trees were introduced into Argentina in 1929 in the Province of Corrientes on a small one-hectare tract of land. Climatic conditions in that province and in the neighbouring territory of Misiones were found to be suitable, closely resembling, it is said, the regions to which they are native in China, in that there are no extremes of cold, late frosts are rare, the climate sub-tropical, and the average rainfall in normal years given as between 1,200 and 1,500 millimetres. Ten years later, in 1939, the number of tung trees had increased to approximately 370,622, of which in that year 48,000 were bearing and were harvested, an average yield of 9·2 kilos of fruit per tree having been obtained.

Expansion of tung orchards is now being officially stimulated by the Ministry of Agriculture in the territory and province just mentioned as partial relief for the acute yerba maté situation, and also because of the value of tung oil in Argentina's paint and varnish industry. The Ministry itself plans on planting 100,000 trees annually for a period of ten years at Government experimental stations located at Loreto and Posados in the territory of Misiones and at the national nursery at Bella Vista in the province of Corrientes. The entire production of tung nuts is consumed in the internal market. The production of tung oil in 1936, 1937 and 1938 was 8, 11 and 30 metric tons respectively.

Of edible oils Argentina has depended almost entirely for its supplies of olive oil on imports from Italy, Spain, France and Greece. There was a considerable increase in the output of domestic edible oil during the 1914-18 war, but subsequently the local oil industry was almost extinguished and by 1930 Argentina found itself the consumer of more than a quarter of the world's exportation of olive oil. The depression of 1931-33, the Spanish civil war and other circumstances imposed a limitation on the imports of oil with a consequent stimulation once more of the domestic industry, until by 1938 the consumption of refined edible oil produced from various locally grown seeds reached the record figure of 74,000 tons.

Apart from linseed, the principal seeds crushed in Argentina are

sunflower, cotton seed, groundnuts, rape seed and spurge, and there is also a relatively small export in these seeds.

Sunflower seed was introduced into the country by Russian settlers some 30 years ago, but it is only in the last few years that there has been any substantial increase in production. The area under sunflowers has risen from 83,685 hectares in 1934-35 to 505,600 hectares in 1939-40, whilst the production of the seed has increased from 61,818 tons in 1934-35 to an estimated output of 385,200 tons in 1939-40. The production of sunflower seed oil in 1938 was 55,645 tons, of cake 41,643 tons and of meal 36,550 tons. The exports of seed, mainly to Europe, reached the record figure of 15,498 tons in 1939, and although these markets are now closed, it is hoped that the domestic oil mills will be able to take up any exportable surplus to make good the deficiency in the supplies of olive oil caused by the entry of Italy into the war.

The production of other oils and by-products in 1938 in metric tons was as follows: cotton-seed oil 10,630, cake 33,415, meal 3,935; rape-seed oil 8,153, cake 10,314, meal 8,719; groundnut oil 6,814, cake 6,033, meal 4,377; spurge-seed oil 784, cake 690, meal 569; grape-seed oil 171; olive oil 67.

The exports of the less important oil seeds from the Argentine have varied considerably from year to year. For example, in the last five years the exports of cotton seed have ranged from 11 to 16,353 tons, of rape seed from, 839 to 34,164 tons, of groundnuts from 564 to 7,493 tons, and of spurge seed from 144 to 4,296 tons.

Owing to the high production costs, the success of the domestic oil crushing industry has been dependent to a large extent on the overseas market for the residual cake and meal, which were shipped mainly to the Scandinavian countries, England, the Netherlands and Belgium. In 1938 the exports of oil cakes and residues were as follows: sunflower seed 72,820, cotton seed 42,726, rape seed 21,014, groundnut 13,176 and linseed 12,988 tons. The sudden cutting off of shipments to Europe resulted in the piling up of huge stocks of cakes in the internal market, reliable sources of information placing the quantity stacked up throughout the country in July at over 50,000 tons. Argentina feeds its animals primarily on pasture, very little corn, cakes, and other feedstuffs being used. Therefore the disposition of this great quantity of cakes is a problem which causes much concern. The Ministry of Agriculture is urging farmers to feed the cakes to livestock and railroads and other large fuel-consuming industries to consume large quantities for fuel purposes in view of the shortage of coal.

The oil millers now find themselves in the peculiar position of being able to make large profits on the one hand through increased demand for and production of domestic oil and of losing on the other hand the greater portion of them through inability to dispose of the accumulation of cake unless present non-European markets for the latter can be expanded or new ones found.

Up to the time of the entry of Italy into the war there was an increasing demand from that country and also from Spain for vegetable oils produced in Argentina, especially sunflower-seed oil. This great increase in foreign demand, combined with the high prices paid, apparently contributed to much speculation in Argentina as to which ultimately would be the more profitable—to hold seeds for export against resumption of trade with Europe or to convert larger quantities into oil and hold the oil for export. The troublesome question of the disposition of the enormous quantities of oleaginous cakes resulting from the latter programme is a deterrent factor, however, and may serve even to check any great expansion in the present production of oil for domestic purposes, bringing about as a consequence a greater consumption of butter and animal fats and greases and the possibility of even permanently weaning public custom away from the present large use of edible oils for cooking purposes. In the latter event, the decline or increase in the production of oleaginous seeds would depend upon foreign demand rather than upon domestic consumption.

A New Rubber Survey of Tropical America.—According to information published in the *Bulletin of the Pan-American Union*, October 1940, pp. 725-728, a survey of the tropical Americas to determine the most promising rubber-producing areas in the Western Hemisphere has begun. It is sponsored by the United States Department of Agriculture and Congress has authorised an appropriation of $500,000 for the necessary research, whilst the Latin-American republics involved are co-operating in the scheme. Three separate parties are taking part in the work, each containing a rubber specialist or agriculturist, a botanist, a pathologist, and a soils expert. Already one party is at work in south-eastern Central America and parts of Colombia, and another in north-western Central America as far as Vera Cruz, Mexico. The third party is on its way to survey an area which covers roughly the headwaters of the Amazon tributaries, that is, the region east of the Andes in Colombia, Peru, Brazil and Bolivia.

Observations made in these surveys, together with the Department of Agriculture's existing knowledge of rubber growing in the Western Hemisphere, will serve as a basis for determining, in co-operation with the countries concerned, the location of at least two experimental bases to be established in the most promising areas. In the words of the then Secretary of Agriculture, Henry A. Wallace, " the project is another step by the Americas for co-operative research in agriculture, the basic industry of this hemisphere." The results of the survey and of the experimental work that follows will be available to any American republic and to all growers, both large and small.

It is claimed that the high-yielding strains of rubber now available in the Americas will offset the labour advantages of the Middle

East, where the industry has been built up on relatively low-yielding seedling strains. But it is worth recalling in this connection that similar high-yielding strains are available too in the Middle East and that all replantings there are of such strains.

One of the most serious drawbacks to rubber in tropical America is the prevalence of the South American leaf disease and it appears to be recognised that an essential desideratum will be the provision by the proposed experimental bases of high-yielding disease-resistant strains.

It is estimated that large areas of the Americas could be in rubber production within 10 years and rubber specialists believe there are millions of acres in tropical America as well adapted to growing rubber as the huge area now planted to that crop in the East. Already two United States firms are planting rubber in Tropical America; one company has about 20,000 acres planted in Brazil and the other about 2,000 acres in Costa Rica and Panama.

Identification of Animal Fibres.—The present increased use of fibre mixtures in textiles makes the identification of the fibres concerned a matter of considerable importance. It is noticeable in such work that the characters of plant fibres and synthetics are more fully dealt with in the literature than those of the various animal fibres of economic importance, on which the readily available information is rather scanty. This need for an account of the animal fibres has now been admirably met in a short memoir published by the Wool Industries Research Association at Torridon, Headingley, Leeds, in conjunction with the International Wool Publicity and Research Secretariat; it is entitled *Animal Fibres of Industrial Importance: Their Origin and Identification*, by A. B. Wildman.

As explained in the preface, it is to serve as a guide to the identification of animal fibres and to their quantitative estimation in mixtures that the memoir is primarily intended. Such work is largely a matter of microscopy, and the descriptions given of the morphological features by which the different fibres can be distinguished are accompanied by notes on the technique of making the microscopic preparations. These accounts are illustrated by over fifty microphotographs which bring out with great clarity the differences in structure and appearance of the various fibres.

In addition to the technical descriptions there are notes on the origin, grades and extent of production of the fibres. Of those dealt with, wool naturally receives the fullest treatment, some information being given on the different types; other fibres described are alpaca, llama, vicuña, camel, mohair, cow and calf, cashmere, musk ox and American bison.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

Soils and Manures

Nigeria.—The following statements relating to work on manures is contained in the report of Mr. W. A. Watson, Agricultural Chemist, Northern Provinces, for January to June 1940.

Permanent Manurial Experiment.—This experiment, in which a dressing of two tons of farmyard manure is compared with equivalent combinations of NP and K was continued for the third year. The land was cropped with a local bulrush millet, maturing very early, followed by sweet potatoes (*Ipomoea batatas*) planted before the millet had ripened, and maturing much later.

The complete mineral dressing gave a significant increase over the farmyard manure for the grain and straw of the millet. The sweet potatoes gave no significant differences either for tops or tubers.

Rock Phosphate.—Two years ago an experiment with finely ground rock phosphate was laid down in an effort to increase its availability. There seemed a possibility that by continued contact with farmyard manure throughout a whole year it might be brought into a more available form. For comparison, rock phosphate was added in similar quantity to an equal weight of manure just before the latter was carted out of the pens. No differences were noted in the crops subsequently grown, nor were there any differences between the residual values in the following year.

As conditions are very dry in Northern Nigeria during the greater part of the time the manure is being made it was thought that if steps were taken to keep the manure moist at all times an improvement might be obtained. The manure resulting from this treatment was again compared with manure to which the rock phosphate was added just before carting. A crop—in this instance sweet potatoes—grown on the area so treated showed no differences.

It is therefore concluded that there seems little hope of increasing the availability of rock phosphate in Northern Nigeria, and neither the medium nor the soil are sufficiently acid to be able to exert any soluble action. There are great deposits of rock phosphate in Southern Nigeria, and the continuous drain of phosphate which such export crops as ground nuts entail may make it necessary in the future to make good the depletion of these reserves.

Beverages

Cacao

Gold Coast.—The following statement regarding investigations on cacao is taken from the report of the Department of Agriculture for the half-year ending June 30, 1940.

Swollen Shoot Disease.—Two mature trees in insect-proof cages were budded in January with Swollen Shoot buds as a preliminary to transmission experiments. The trees first showed clear signs of infection in April. Since then chlorosis has become general and the swellings pronounced. The type of chlorosis is that already known to be associated very frequently with Swollen Shoot, there being now every indication that it is a direct result of infection.

Flowers have been pollinated on these caged trees to see what effect the disease may have on pod-shedding and to obtain infected beans if transmission can occur in the pod.

To confirm the conclusion (reached on a previous experiment) that Swollen Shoot is not transmitted through the seed, beans from a rounded pod off an infected tree have been planted in cages with beans from an unaffected plot as controls. So far there is no sign of any infection on the seedlings raised from infected trees. However, a much stunted pod taken off an infected tree in March 1939 has given a single surviving seedling which appears to be infected. Very young seedlings (2-3 months) have been found infected; these have been self-sown from infected trees. The possibility of seed infection cannot be ruled out; considering the long period of development on the tree, infection could easily occur, as it does in the case of bean mosaic.

Insect Transmission of Swollen Shoot.—It is suspected from observations on the spread of Swollen Shoot that a small insect which could be wind-borne, is the vector of the disease. As almost all vectors of virus diseases belong to the Hemiptera, attention is being concentrated on this Order. Preliminary tests are made by collecting insects from infected trees and caging them on healthy seedlings. When sufficient insects cannot be found already feeding on infected trees, they are collected, and caged on infected material before transference to the healthy plant. In this way, five cages of the cacao aphis (*Toxoptera aurantii*), ten cages of the cacao psyllid (*Mesohomotoma tessmanni*) and five cages of the cacao thrips (*Heliothrips rubrocinctus*) have been set up.

In addition all minor Hemipterous pests of cocoa are being collected. The coreid, *Cletomorpha lancigera*, has become very common, and an unrecorded fulgorid has also been found in considerable numbers.

Cereals

Guinea Corn

Nigeria.—Mr. F. O. T. James, Senior Agricultural Assistant, Northern Provinces, in his half-yearly report for January to June

1940 states that two years ago a departure was made in the old-time single plant selection of guinea corn. Mass selection on a wider area has been adopted and recent results have justified this method. It is likely therefore that guinea corn, like maize, may be susceptible to heterosis. The results of the trials at Kano and Zaria are given below :

Guinea Corn Trial at Kano

Varieties.	Yield of Grain per acre. lb.	Percentage.
4	1,144	100
2	1,085	94·5
1	873	76·0
3	873	76·0

Varieties 4 and 2 are significantly better than varieties 3 and 1.

Guinea Corn Trial at Zaria

Varieties.	Yield of Grain per acre. lb.	% of Standard.
6	1,770	152·5
5	1,630	140·5
4	1,620	140
1	1,430	122·5
2	1,420	122
9	1,375	119
3	1,320	113·5
8	1,370	113
7	1,210	104
Local mixture	1,160	100

Variety 6 is significantly better than varieties 3, 7, 8, 9 and Local Mixture.

Variety 5 is significantly better than varieties 7 and Local Mixture.

In each of these trials and in those trials carried out earlier, two points are worth observing :

(*a*) The yellow testa (kaura) varieties are superior in yield to those with white testa, and are usually fed to cattle and horses.

(*b*) The white testa (farafara) varieties command a quick market with slightly higher price and are usually used for human consumption.

An intermediate colour testa which is cream, and known as mori, might prove a real "go-between" with far-reaching consequences. Breeding work has been started on this.

Legumes

Pigeon Peas

Nigeria.—Mr. F. O. T. James, Senior Agricultural Assistant, Northern Provinces, in his half-yearly report for January to June 1940 states that as a result of continuous and steady propaganda pigeon peas are becoming more popular among the natives. The

economic purposes for which the crop can be used include: (1) as human food, different kinds of dishes being prepared from the seed, green or dry; (2) the dry seeds are used as concentrate in feeding livestock, especially cattle and goats, the protein content being high (about 24 per cent.); (3) by regular but judicious cutting, the leaves are available and used as green fodder for cattle and goats.

The result of the yield trial of the Pusa strains recently introduced against the local kind is given below:

Varieties.	Total yield of Seed from Plants. *lb.*	Yield of Seed per acre. *lb.*	% of Standard.
Pusa 69 . . .	85	623	116
Pusa 51 . . .	84	578	108
Standard (local type)	78	537	100
Pusa 16 . . .	87	599	112
Pusa 15 . . .	82	530	99
Pusa 80 . . .	78	537	100

These were planted through a millet crop, which suffered no depression therefrom. The zero crop, in fact, gave 880 lb. of grain per acre.

Sugar

Cane

Antigua.—The following account of the results of sugar cane experiments carried out by the Department of Agriculture is taken from the report of the Agricultural Superintendent for July to December 1939.

The experiments reported on form portion of a comprehensive series conducted under the auspices of the Antigua Sugar Cane Investigation Committee, and under the direction of Mr. P. E. Turner, Adviser in Sugar Cane Experiments to the Commissioner of Agriculture.

Originally the experiments on the Gunthorpe, Tudway and Codrington Estates and on Delaps were under the control of Mr. C. F. Charter, Agronomist to the Gunthorpe Estates, while the remaining experiments were under the control of the Agricultural Department. Mr. Charter, however, left Antigua during 1937, and those experiments planted by him before that date were reaped under the supervision of the Agricultural Department.

A summary of the results of certain of these latter experiments is given below. Details as to sites, layout of experiments and yield data, with respect to those experiments entirely under the control of the Department, have also been received at the Imperial Institute, and may be consulted on request.

The thanks of the Agricultural Superintendent are due to Mr. Turner for soil analyses, for statistical analysis of the results, and for general advice and assistance in the preparation of the report, and to the Antigua Sugar Factory for analysis of juices from the plant cane varietal experiments.

Varietal Experiments

Four new varieties, B 3013, B 3124, B 3127, and B 3439, were included in the plant cane experiments reaped during 1939 on Fitches clay in No. 23 Cassada Garden, and on Gunthorpe clay in No. 8 Cassada Garden.

B 3439 has done particularly well at both stations. It has headed the list with respect to yields both of canes and of sugar on the Gunthorpe clay, the figures being 35·06 tons per acre and 5·11 tons per acre respectively.

On the Fitches clay soil this variety yielded 39·58 tons cane per acre but was outyielded significantly by B 2935 (47·59 tons per acre) and Ba 11569 (45·47 tons cane per acre). B 3439, however, again headed the list with respect to sugar production with 5·69 tons per acre.

B 3439 is a cross between Ba 11569 and a Queensland variety, Q 813. It germinates well and makes rapid early growth, covering the land at an early stage. It gives a heavy fall of trash and is resistant to drought. It possesses excellent juice qualities. Under Antigua conditions it arrows slightly.

This cane is easily the most promising of the new seedlings; the other three, however, are being given with B 3439 a more extended trial on a number of soil types.

B 2935 has again given good results on Fitches clay soils. As already stated, this variety has yielded 47·59 tons cane per acre as a plant cane at Cassada Garden. It has headed the list as a first ratoon at Comfort Hall with 22·72 tons cane per acre, and as a second ratoon at Gaynors with 29·09 tons cane per acre. As a second ratoon at Cassada Garden[1] it has filled second place with a yield of 20·55 tons cane per acre and at Vernons[1] as a first ratoon it has filled the second place with 16·82 tons cane per acre.

With respect to the two crops at Comfort Hall and Vernons (plant cane and first ratoons) and to the three crops at Gaynors and Cassada (plant cane, first ratoons and second ratoons), B 2935 has in each case topped the list or filled the second position.

The following table shows the station and the total yield of canes over the two or three crops, as the case may be, both for the leading cane and the variety next in order to it.

Station.	Leading Variety.	Total yield of Canes.	Second Variety.	Total yield of Canes.	Difference.
		Tons per acre.		*Tons per acre.*	
Comfort Hall	B 2935	52·46	Ba 11569	40·17	12·29
Vernons	Ba 11569	58·04	B 2935	57·42	0·62
Gaynors	B 2935	124·92	Ba 11569	112·08	12·84
Cassada Garden	B 2935	89·77	Ba 11569	82·51	7·26

On other soil types B 2935 in most cases has not proved satisfactory. In an experiment on a calcareous Gunthorpe clay at

[1] Experiment planted by C. F. Charter.

Blakes it has beaten Ba 11569 and B.H. 10·12 both as a plant cane and as a first ratoon. B 2935 has also done well over a series of three crops on Tomlinson clay,[1] topping the list as a plant cane but falling to second place as a first ratoon and to sixth and last place as a second ratoon.

On Gunthorpe clay at North Sound,[1] on Otto clay at La Roches, and on Blubber Valley loam at Jolly Hill it has proved a failure.

These results fully confirm the conclusions recorded in the report for 1938 to the effect that while B 2935 can confidently be recommended for the soils of the Fitches suite, its extension on other soils should be watched with care in view of its failure on poorly drained land.

Ba 11569 has again done well both as a plant cane and as a ratoon in all the experiments in which it was included. This variety is the most suitable of the standard varieties for Gunthorpe, Otto and Tomlinson clays, and probably also for Lindsey clays, but there are indications that B 3439 may prove a successful competitor.

The latter variety may also prove very suitable for the Bendal and Blubber Valley soils where its rapid germination and spreading early growth may enable it to compete not only with Ba 11569 but also with P O J 2878, which is a favourite variety with some growers for wet poorly drained grassy soils.

Results of the 1939 experiments confirm the opinion expressed in the 1938 report to the effect that B 147 (B 4507) should no longer be grown.

B.H. 10·12 has proved markedly inferior to Ba 11569 as a plant cane on Gunthorpe clay at Cassada Garden (Ba 11569—30·9 tons per acre, B.H. 10·12—26·09 tons per acre). It has proved inferior to Ba 11569 as plant cane in 1938 and first ratoon in 1939 on Gunthorpe clay at Blakes and at North Sound,[1] and as plant cane in 1937, first ratoon in 1938 and second ratoon in 1939 on Fitches clay at Gaynors, and on Blubber Valley Loam at Jolly Hill. There is little doubt but that higher yields would result from the substitution of Ba 11569 for B H 10·12 on some of the better soils on which the latter variety is still grown.

B 728 has given much the same yield as B H 10·12 in experiments in which they have both been included. This cane is not well suited to the climatic conditions ordinarily experienced in Antigua.

Co 213 has been beaten as a first ratoon at Comfort Hall by B 2935 and Ba 11569, and although superior to these varieties as a second ratoon on Tomlinson clay at Tomlinsons it has been beaten by them over the series, plant cane, first ratoon, second ratoon.

Manurial and Cultural Experiments

During 1939 experiments have been reaped in which pen manure has been compared with an inorganic fertiliser.

[1] Experiment planted by C. F. Charter.

At Jolly Hill on Blubber Valley Loam the gains in yield of plant cane from a complete inorganic manure have exceeded those resulting from pen manure alone.

At Cassada Garden on Gunthorpe clay the gains in yield of plant cane from sulphate of ammonia plus superphosphate have approximated to the gains resulting from pen manure alone, while on Fitches clay at Lavingtons the gains from sulphate of ammonia plus superphosphate have been inferior to those resulting from pen manure of very high quality.

At Greencastle Experiment Station on Bendal clay it has been shown that the residual of pen manure applied to the plant canes is greater than the residual effect of a complete inorganic fertiliser. All plots received sulphate of ammonia as first ratoons.

Significant gains in yield of plant cane have resulted from combinations of nitrogen and phosphate both with and without potash on Otto clay at Willis Freemans and from nitrogen with phosphate on Gunthorpe clay at North Sound.

At North Sound on Gunthorpe clay, and at La Roches on Otto clay, significant gains in yield have resulted from the application of late dressings of sulphate of ammonia in the presence of basal superphosphate. In one experiment at North Sound significant and economic gains have also resulted from early sulphate of ammonia in the presence of basal phosphate, but without the application of late sulphate of ammonia, and almost identical gains were noted from late sulphate of ammonia in the absence of an early application.

In three experiments late applications of superphosphate were given in addition to the early basal application. In no case was there a significant response.

At Millars on a Fitches clay an experiment with sulphate of ammonia, superphosphate and sulphate of potash applied alone and in various combinations has now been carried to the second ratoon stage. As plant canes and as first ratoons gains from nitrogen have been independent of the presence of phosphate or potash, but as second ratoons the gains from nitrogen have been rather greater in the presence of applied phosphate.

A somewhat similar instance of the increased phosphate deficiency with second ratoons has been observed at Fitches Creek[1] on a Gunthorpe clay. In this experiment the gains from nitrogen, both of the plant cane and of the first ratoons, have been greater in the presence of applied phosphate, while in the case of the second ratoons gains from nitrogen were almost entirely dependent on the presence of phosphate.

At Belvidere considerable gains in yield of first ratoons (6·83 tons per acre) have resulted from the application of 1½ cwt. sulphate of ammonia to the ratoons in the presence of phosphate and potash.

[1] Experiment planted by C. F. Charter.

There has also been a small residual effect from late sulphate of ammonia applied to the plant cane crop.

Significant gains in yield of first ratoons have been obtained on Otto clay at Ottos from applications of sulphate of potash in the presence of basal sulphate of ammonia. A similar result was observed with the plant cane crop in 1938. The increases in yield resulting from applied phosphate in the plant cane crop and from residual phosphate in the ratoons cannot be shown to be statistically significant, but early applications of phosphate appear to be more effective than late.

In an experiment on Fitches clay at Langfords phosphate and potash in the presence of basal nitrogen gave both as plant canes and as ratoons small increases in yield which could not be established as statistically significant.

In general the conclusions set forth in the report for the year 1938 have been confirmed. These conclusions may be summarised as follows. Plant canes will normally respond to early applications of pen manure, filter press mud and inorganic mixtures containing nitrogen and phosphate. Potash appears to be beneficial on certain soils but is less generally required than nitrogen and phosphate.

The beneficial effects of pen manure and of filter press mud persist in the ratoon crops.

Ratoons respond to applications of inorganic fertilizers, especially to sulphate of ammonia. On many soils, however, this response to nitrogen is greater in the presence of phosphate. Occasionally potash is beneficial.

Fruits

Citrus

Gold Coast.—The following account of investigations on citrus fruit piercing moths is contained in the report of the Department of Agriculture for the period January to June 1940.

Special attention has been paid to the known and potential food plants of *Othreis* and *Achaea* spp. and to the habitat and plant associations in which they occur and a considerable amount of valuable information has been secured. Much progress has been made in the study of the comparatively neglected family Menispermaceæ, to which all the known food plants of the three species of moth *Othreis* in West Africa belong. Whereas only 10 species have been recorded hitherto from the Gold Coast (including Togoland), 36 have now been found up to date.

Nightly collections of moths are yielding data of value, especially when taken in conjunction with collections from other localities and with systematic counts of punctured fruits, and it is hoped to extend the former observations further afield while the infestation lasts. The records are showing interesting variations in the distribution of the main pests, especially in regard to *Othreis divitiosa*

and *O. fullonica*, and tend against the hypothesis of long distance migration by these moths and probably most of the other fruit piercers as well.

Ten freshly emerged (bred) *Othreis divitiosa* were confined in a large airy cloth-covered cage on June 3 and have been provided with fresh fruit daily. On June 30, four of them were still alive, indicating already that the adult life can be measured in terms of weeks rather than days. Conclusions from this preliminary experiment are awaited with interest, and early in July a similar test with a typical *Achaea* (*A. mormoides*) will be undertaken.

Mass cultures of *Achaea mormoides*, and more recently of *A. albifimbria*, both on *Alchornea cordifolia* and of *Melipotis subsignata* on *Baphia nitida* and *Pterocarpus santalinoides* are yielding useful information on their hitherto unknown early stages. Eggs have been secured from several other species, including most of the more important fruit piercers, and life history studies are in progress.

Nigeria.—Mr. F. O. T. James, Senior Agricultural Assistant, Northern Provinces, in his half-yearly report for January to June 1940, refers to the work on citrus which is being undertaken in Northern Nigeria with the object of producing fruit for local consumption, as part of the scheme for the improvement of native diet. The nurseries which have been established for citrus propagation at Bida, Zaria and Kano are progressing. Bida has 153 budded trees and 3,300 seedlings. Zaria, in addition to care of old trees and other work, budded and distributed 503 sweet oranges and 144 grapefruit trees. Kano serves a great population and has an extensive programme for the budding and distribution of trees.

Spices

Ginger

Nigeria.—The report of Mr. W. A. Watson, Agricultural Chemist, Northern Provinces, for January to June 1940 contains the following statement relating to the work which is being carried out on the improvement of Nigerian ginger.

As a result of intense propaganda by the Agricultural Department a great improvement in the quality of the cured ginger offered for sale took place in 1938-39. There was, however, still a fair proportion of ginger which fell below the minimum standards laid down by the British Pharmocopoeia.

To re-establish the good name of Nigerian ginger on the home market it was resolved that for the 1939-40 season all cured ginger exported should quite definitely have an analysis at least as good as that demanded by the British Pharmocopoeia.

To achieve this it was necessary to concentrate on only a part of the ginger-producing area and to restrict curing to that area. The actual curing operations were done under the close supervision

of the Department. Central washing stations were set up, to which villages brought their scraped dried ginger. The curing consists of soaking the ginger in water for two minutes and then washing it with the hands for three minutes. After this the washing water is poured away and the ginger taken home to the villages to be dried on mats and brought again next morning for a repeat performance. Normally six such soakings and washings will produce ginger of the required colour and physical characteristics. To ensure that in arriving at this state no undue loss of chemical constituents was taking place samples were taken after each washing and analysed. The water soluble ash was given particular attention, and if the amount appeared to be becoming dangerously low further washing was stopped. Earlier determinations showed that the soluble constituents are lost in this washing process at a fairly regular rate, and thus one could forecast with fair accuracy the amount of washing permissible with safety. In practice it was found that, with the restricted soaking and washing (timed by an egg boiler) the required colour was attained without excessive loss of soluble constituents.

From these central washing stations the ginger came to the central market to be sold for export. We had promised the firms buying a certificate of quality for each batch of 25 cwt. sold. This certified that the ginger of that batch was up to B.P. standards. Although pre-market sampling had shown beyond reasonable doubt that the ginger was satisfactory, a sample was taken from each batch in a systematic way, and on the result of the analyses of this sample the certificate was issued. In every instance the sample showed an analysis well above B.P. needs.

For this sampling work a laboratory was specially erected in the area, and several hundred samples were dealt with on the spot. It is hoped next year to enlarge the area producing cured ginger, but continuous close check will need to be maintained by analysis, especially if reduced supervision is contemplated in areas which have been satisfactory this year.

FORESTRY

Timbers

Nigeria.—The following report on research work on timber utilization in respect of the half-year ending June 30, 1940, has been furnished by the Conservator of Forests.

Data on the strength, working qualities, durability and treatability of Nigerian timbers is steadily increasing, in anticipation of intensive working of our forests in the future. It is probable that the majority of our woods will be useful for some purpose, and many of those at present disregarded, but which respond readily to treatment, may prove to be among our more widely useful species within the country.

The treatment of logs, poles and lumber is receiving particular attention. Pinhole borers, powder-post borers, staining and sun splitting are the principal sources of damage during logging, and adequate treatment can prevent all these.

Treatment will vary with different species, means of extraction and transport, distance from mill or waterway, and the purpose for which the logs are to be used. It remains to be seen whether methods suggested are fully effective and commercially possible. It would take too much space to describe these in detail. The control of powder-post damage has been investigated from various standpoints. The distribution of starch in growing trees is recorded monthly in relation to season, growth and fruiting. Reduction in starch by log seasoning methods is being explored. Treatment of sawn timber by various hot or cold dips has been found ineffective unless a moderate penetration is obtained, and in the case of Obeche open tank treatment or prolonged steeping is required. This may be of value for the full utilization of Obeche and other woods for boxboards. With proper attention none of these sources of degrade should be serious.

With the reduction of import of steel and iron, timber will be in greater demand within the country, and the adoption of shingles to replace " pan," wooden sleepers to replace steel sleepers, locally-produced box boards to replace imported shooks, all have problems which are being dealt with.

Resins

Nigeria.—According to the report of the Conservator of Forests for January to June 1940 an effective adhesive to catch the moth, *Ephestia cautella*, which causes so much damage to stored cacao, has been found in the coagulated latex of the vine, *Carpodinus hirsuta* (Yor. " Ate "). The latex has a high percentage of resin, and adequate supplies are available.

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IMPERIAL INSTITUTE

CONSULTATIVE COMMITTEE ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

QUARTERLY BIBLIOGRAPHY ON INSECTICIDE MATERIALS OF VEGETABLE ORIGIN, NO. 12

(July to September, 1940.)

Prepared in collaboration with the Imperial Institute of Entomology and the Department of Insecticides and Fungicides, Rothamsted Experimental Station.

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Toxicities to the Housefly of Smoke from Derris and Pyrethrum. By L. D. Goodhue and W. N. Sullivan. *J. Econ. Ent.*, 1940, **33**, No. 2, 329-332. Derris effectively dispersed as smoke.

Relative Susceptibility of the Ootheca and Adult Female of the German Cockroach to Liquid Household Insecticides. By Barbara M. Parker and F. L. Campbell. *J. Econ. Ent.*, 1940, **33**, No. 2, 275-278. Pyrethrins and rotenone tested.

Dusts on Hops for Control of the Red Spider. By H. E. Morrison and D. C. Mote. *J. Econ. Ent.*, 1940, **33**, No. 4, 614-619. Various insecticides of vegetable origin compared with dinitro-o-cyclohexyl phenol.

La teigne des crucifères au Congo Belge. By J. Ghesquière. *Bull. Cerc. Zool. Congol.*, 1939, **16**, Fasc. 1-2. (61)-(66), in *Rev. Zool. Bot. Afr.*,

33, Fasc. I. (*R.A.E.*, 1940, **28**, A, Pt. 8, 437-438). Reference to tests with pyrethrum and derris dusts and nicotine sprays in controlling *Plutella maculipennis*. All gave good results but derris dust proved the most suitable.

ALKALOID-CONTAINING MATERIALS

Tobacco Products, including Nicotine and Nicotine Derivatives

Nicotine Sulphate Production Planned—Egypt. *World Tr. Notes, U.S. Dep. Comm.*, 1940, **14**, No. 31, 504.

Nicotine Sulphate Imports Decline—Canada. *World Tr. Notes, U.S. Dep. Comm.*, 1940, **14**, No. 25, 402.

Unusual Development of Apple Perennial Canker, following Application of Toxic Wound Dressings. By E. L. Reeves, M. A. Yothers and C. W. Murray. *Phytopathology*, 1939, **29**, No. 8, 739-743. (*R.A.E.*, 1940, **28**, A, Pt. 7, 342). No injury to plant tissues from dressings containing ground-nut oil in combination with nicotine sulphate.

Effect of Fruit Growth and Weather on Deposits of Insecticides on Apples in Southern Indiana. By J. E. Fahey and H. W. Rusk. *J. Econ. Ent.*, 1940, **33**, No. 3, 505. Fixed nicotine preparations tested.

Toxicity of Nicotine administered internally to Several Species of Insects. By R. Hansberry, W. W. Middlekauf and L. B. Norton. *J. Econ. Ent.*, 1940, **33**, No. 3, 511.

Nicotine Gassing of Beet Pests. *Int. Sug. J.*, 1940, **42**, No. 501, 312 (from *Sugar Beet Rev.*, **14**, No. 4, p. 53). Note describing equipment and technique for application of nicotine vapour to control beet aphis.

Toxicity Studies of Mixtures of Nicotine and Naphthalene as Fumigants. By H. H. Richardson. *J. Econ. Ent.*, 1940, **33**, No. 2, 368-372.

Substitute Spray Materials, II. By C. G. Vinson and S. A. McCrevy. *Research Bull., No.* 316, *University of Missouri Agric. Exper. Sta.*, 1940. Describes procedure and effective control given by the use of nicotine-bentonite against the codling moth.

Bionomics and Control of the Indian Sugar-Cane Leafhopper, *Pyrilla perpusilla* Wlk. (Rhyncota, Fulg.), in the Punjab. By Khan A. Rahman and Ram Nath. *Bull. Ent. Res.*, 1940, **31**, Pt. 2, 179-190. Both nicotine dust and nicotine sulphate-fish oil soap mixture gave 100 per cent. mortality.

Control of Green Spruce Aphis. *Quart. J. For.*, 1940, **34**, No. 3, 117. Brief note reporting that nicotine spray gave successful control in the nursery.

Bean Fly Control in Southern Queensland. By N. E. H. Caldwell. *Queensld. Agric. J.*, 1939, **52**, Pt. 4, 393-396 (*R.A.E.*, 1940, **28**, A, Pt. 7, 332). Nicotine sulphate spray recommended.

Other Alkaloid-containing Materials

Unusual Development of Apple Perennial Canker, following Applications of Toxic Wound Dressings. By E. L. Reeves, M. A. Yothers and C. W. Murray. *Phytopathology*, 1939, **29**, No. 8, 739-743. (*R.A.E.*, 1940, **28**, A, Pt. 7, 342). No injury to plant tissues noted from dressings containing ground-nut oil in combination with anabasine sulphate.

INSECTICIDE MATERIALS CONTAINING ROTENONE AND ALLIED SUBSTANCES

General

Definition of the Word "Rotenoid." By R. C. Roark. *J. Econ. Ent.*, 1940, **33**, No. 2, 416.

Imports of Rotenone Bearing Roots into the United States. *World Tr. Notes, U.S. Dep. Comm.*, 1940, **14**, No. 31, 505.

Rotenone Root Imports Up. *Soap*, 1940, **16**, No. 9, 117. Brief note on imports of derris and lonchocarpus roots into the U.S.A., with countries of origin.

Rotenone Products and their Application. By P. Desaymard. *Revue Viticult.*, 1939, **90** (46), 327-330. Claims that only "stabilised" products give indisputable lasting properties.

Mosquito Larvae Control. *Soap*, 1940, **16**, No. 9, 109. Brief note. Derris and other rotenone powders more effective when distributed on the surface of the water than when wetted and deposited at the bottom.

The Medication of Cattle for the Control of Horn Flies. By W. G. Bruce. *J. Kansas Entomol. Soc.*, 1940, **13**, 41-43 (*Chem. Abstr.*, 1940, **34**, No. 13, 4515). Rotenone given internally proved effective in preventing the development of *Hæmatobia irritans* larvæ in cattle droppings.

A New Machine for Turf Dusting for Hairy Chinch Bug Control. By L. Pyenson. *J. Econ. Ent.*, 1940, **33**, No. 1, 153-155. Apparatus by which rotenone dusts may be applied to turf.

Rotenone-bearing Insecticides for Control of the Elm Leaf Beetle, *Galerucella xanthomeleana* Shrank. By F. L. Gambrell. *J. Econ. Ent.*, 1940, **33**, No. 2, 264-269. Useful control.

Notes on the Control of Onion Thrips. By L. D. Anderson and H. G. Walker. *J. Econ. Ent.*, 1940, **33**, No. 2, 278-280. Emulsified oil-rotenone extract of little use.

Pea Aphid Control in Maryland during 1939. By L. P. Ditman, C. Graham and E. N. Cory. *J. Econ. Ent.*, 1940, **33**, No. 3, 477. Derris and cube tested.

Test Cabbage Pest Control. *Soap*, 1940, **16**, No. 9, 117. Derris sprays and dusting mixtures of derris or cube are noted as giving satisfactory control of various cabbage and cauliflower caterpillars.

Rotenone for Black Scale. *Soap*, 1940, **16**, No. 9, 118. Notes on the effectiveness of rotenone with low dosages of oil in the control of Black Scale of citrus trees. Satisfactory results except on very heavy infestations.

Derris

Derris or Tuba Root. By R. R. Worsley and F. M. Rogers. *E. Afr. Agric. J.*, 1940, **6**, No. 1, 50-53. General account of cultivation, harvesting and preparation of derris under East African conditions, based on trials carried out at the Agricultural Experiment Station at Amani.

Fish Poison Plants and other Vegetable Insecticides. *Derris* spp. *Forest Research in India and Burma*, 1938-39, Pt. 1 (1940), pp. 80-82. *Derris ferruginea* Benth. established as occurring wild in Assam, found to contain 3 per cent. rotenone. Rotenone also found in *D. cuneifolia* and acidic substances related to rotenone isolated from *D. scandens*. Cultivation trials with *D. elliptica* and *D. malaccensis* unsuccessful.

Philippine Islands Derris Root Exports. *Chem. and Drugg.*, 1940, **133**, No. 3161, 134. Brief note of Philippine Islands exports during 1939.

New Constituents of Derris Root, III. By T. M. Meyer. *Rec. Trav. Chim. Pays-Bas*, 1939, **58**, No. 12, 1119-1123.

The Active Principles of Leguminous Fish-poison Plants. Part 5. *Derris malaccensis* and *Tephrosia toxicaria*. By S. H. Harper. *J. Chem. Soc.*, 1940, August, 1178-1184. Details of a study of the chemistry of the resins from these two plants. A new phenol was isolated from the derris resin.

Kwaliteitsomschrijving van Derrispoeder. By W. Spoon. *Bergcultures*, 1940, **14**, No. 18, 593-595. Discussion of specification for derris powder.

Toxicities to the Housefly of Smoke from Derris and Pyrethrum. By L. D. Goodhue and W. N. Sullivan. *J. Econ. Ent.*, 1940, **33**, No. 2, 329-332. Derris effectively dispersed as smoke.

La teigne des crucifères au Congo Belge. By J. Ghesquière. *Bull.*

Cerc. Zool. Congol., 1939, **16**, Fasc. 1-2 (61)-(66), in *Rev. Zool. Bot. Afr.*, **33**, Fasc. 1 (*R.A.E.*, 1940, **28**, A, Pt. 8, 437-438). Derris dust proved the most suitable material for controlling *Plutella maculipennis* in tests in which pyrethrum dusts and nicotine sprays also gave good results.

Lonchocarpus

Brazilian Timbo. By James Sorrel. *Soap*, 1940, **16**, No. 9, 99, 101, 103. Gives details of the regions of production and of the system of drying, milling and preparation for the market.

Spray Residue and Substitutes for Lead Arsenate in Control of Cherry Fruitflies. By D. W. Hamilton. *J. Econ. Ent.*, 1940, **33**, No. 3, 447. Cube and phenothiazine reduced heavy populations satisfactorily as compared with basic zinc arsenate which was only partially successful in two light applications.

Others

The Active Principles of Leguminous Fish-poison Plants. Part 5. *Derris malaccensis* and *Tephrosia toxicaria*. By S. H. Harper. *J. Chem. Soc.*, 1940, August, 1178-1184. Details of a study of the chemistry of the resins obtained from these two plants.

PYRETHRIN-CONTAINING MATERIALS

Notes on Pyrethrum in the Southern Highlands. By C. J. McGregor. *Planter, Tanganyika*, 1940, **8**, No. 4, 5, 16 and No. 5, 5, 14. Detailed notes on cultivation and drying of pyrethrum under Tanganyika conditions.

Fish Poison Plants and other Vegetable Insecticides. *Forest Research in India and Burma.* 1938-39. Pt. 1 (1940), pp. 80-82. Reference to pyrethrum from India.

Pyrethrum Production Established—Tanganyika. *World Tr. Notes, U.S. Dep. Comm.*, 1940, **14**, No. 24, 387.

Pyrethrum Culture Aided—Peru. *World Tr. Notes, U.S. Dep. Comm.*, 1940, **14**, No. 33, 537. After satisfactory cultivation trials at La Molina Agricultural Experiment Station the Peruvian farmers are to be encouraged to grow pyrethrum by the offer of a Government subsidy.

Pyrethrum in California. *Soap*, 1940, **16**, No. 9, 117. Brief note on cultivation trials in California with mention of production in Pennsylvania.

Pyrethrum from the Belgian Congo. *Chem. and Drugg.*, 1940, **133**, No. 3161, 134. Brief note and estimate of 1940 crop.

Dalmatian Pyrethrum Crop Forecast. *Chem. and Drugg.*, 1940, **133**, No. 3163, 160, and *Chem. Tr. J.*, 1940, **107**, No. 2784, 198. Brief note that Dalmatian crop for 1940 is estimated at less than the 950 tons of 1939. Statement of unsold stocks.

Pyrethrum Exports Increased—Kenya. *World Tr. Notes, U.S. Dep. Comm.*, 1940, **14**, No. 21, 331.

Pyrethrum Supplies May be Controlled—Japan. *World Tr. Notes, U.S. Dep. Comm.*, 1940, **14**, No. 22, 352, and *Soap*, 1940, **16**, No. 7, 122. Note regarding Japanese semi-official Farm Products Export Company which is to collect and distribute certain agricultural products, including pyrethrum.

Pyrethrum Crop Reported Short—Yugoslavia. *World Tr. Notes, U.S. Dep. Comm.*, 1940, **14**, No. 32, 523.

Pyrethrum Supply Limited—Brazil. *World Tr. Notes, U.S. Dep. Comm.*, 1940, **14**, No. 26, 421.

Pyrethrum Extraction. Abstract from Paper in *Lenin Acad. Agr. Sci.*, 1938, in *Soap*, 1940, **16**, No. 8, 109. 100 per cent. extraction of pyrethrin I was obtained in 6 to 8 hours by a hot method.

Home-made Stock Sprays. By Craig Eagleson. *Soap*, 1940, **16**, No. 8, 93-95, 107. Studies of pyrethrin content of home-extracted pyrethrum sprays indicate that such are not economical.

New Pyrethrum Labels Effective, September 1st. *Soap*, 1940, **16**, No. 8, 115.

Pyrethrum Labelling. *Oil, Paint, Drug Rep.*, 1940, **137**, No. 26, 51. Note on address given at meeting of the National Association of Insecticide and Disinfectant Manufacturers.

Pyrethrum Deterioration. By A. Weed. *Soap*, 1940, **16**, No. 7, 101, 103. Loss in pyrethrins of pyrethrum powder on keeping discussed in the light of the new labelling regulations in the U.S.A.

Pyrethrum Mixtures. *Soap*, 1940, **16**, No. 9, 115. Brief note. Increase in adhesive properties and decrease in activity of pyrethrum powder diluted with talc.

Mosquito Control. By E. I. McDaniel. *Michigan Agric. Expt. Sta., Quart. Bull.*, 1940, **22**, 32-34 (Abstract in *Soap*, 1940, **16**, No. 8, 115). Particulars are given for making up a pyrethrum emulsion.

Studies of Mosquito Repellants. II. Relative Performance of certain Chemicals and commercially available Mixtures as Mosquito Repellants. By P. Granett. *J. Econ. Ent.*, 1940, **33**, No. 3, 566-571. Oil of citronella and pyrethrum mixture compared with a proprietary repellant.

Mosquito Repellant. *Soap*, 1940, **16**, No. 8, 92. Brief note; pyrethrum-containing liquids and ointments were tried.

The Repellancy of Pyrethrum Dusts to the Beet Leafhopper on Tomatoes. By B. F. Coon and C. Wakeland. *J. Econ. Ent.*, 1940, **33**, No. 2, 389-393.

Some Experiments with Certain Liquid Insecticides in Houses Infested with the Bed-bug, *Cimex lectularius*. By A. J. Musgrave. *J. Hyg. Camb.*, 1940, **40**, No. 4. Pyrethrum and β-butoxy-β'-thiocyanodiethyl ether showed promise.

Control of the Hawaiian Beet Webworm. By H. G. Walker and L. D. Anderson. *J. Econ. Ent.*, 1940, **33**, No. 2, 272-275. Pyrethrum powder dust gave very good control.

Pentatomids Attacking Tomatoes and Experiments on their Control. By F. G. Mundinger. *J. Econ. Ent.*, 1940, **33**, No. 2, 275-278. Pyrethrum dust preparation gave better control than nicotine or derris.

Cockroach Control. *Soap*, 1940, **16**, No. 9, 109. Brief note. Pyrethrum kerosene sprays held to be ineffective.

Test Cabbage Pest Control. *Soap*, 1940, **16**, No. 9, 117. Pyrethrum dust mixtures are among those noted as giving satisfactory control of various cabbage and cauliflower caterpillars.

The Wattle Leaf-tier. By L. B. Ripley. G. A. Hepburn, B. K. Petty, and J. Dick. *Fmg. S. Afr.*, 1939, September, Repr. No. 94, 3 pp. (*R.A.E.*, 1940, **28**, A, Pt. 8, 405-406). Pyrethrum dust and talc (1 : 20) gave promising results for control.

OTHER INSECTICIDE MATERIALS OF VEGETABLE ORIGIN

Constituents of Certain Species of Helenium. IV. Concerning the Compound melting at 233-234° obtained from *Helenium tenuifolium*. *J. Amer. Chem. Soc.*, 1940, **62**, No. 8, 2154-2156.

The Identity of Obaculactone, Evodin and Dictamnolactone with Limonin. By M. S. Schlechter and H. L. Haller. *J. Amer. Chem. Soc.*, 1940, **62**, 1307. Obaculactone occurs in the fruit of the amur cork tree (*Phellodendron amurense* Rupr.) the insecticidal properties of which are being studied.

Report on Coffee Stem Borer Work in Coorg. By V. K. Subramanyam. *Plant. Chron.*, 1940, **35**, No. 14, 287. Reference to use of stem washes of cashew nut shell oil emulsion which proved effective as an ovicide.

BOOK REVIEWS

Books for review should be addressed to " The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

AN AGRICULTURAL TESTAMENT. By Sir Albert Howard, C.I.E., M.A. Pp. xv + 253, 8½ × 5½. (London, New York and Toronto: Oxford University Press, 1940.) Price 15s.

The purpose of this book, as stated in the Preface, is to draw attention to the destruction of the earth's capital—the soil; to indicate some of the consequences of this; and to suggest methods by which the lost fertility can be restored and maintained. As readers of his earlier book, *The Waste Products of Agriculture*, and his numerous other publications will be aware, Sir Albert Howard was the creator of the Indore method for maintaining soil fertility by the manufacture of humus from vegetable and animal wastes. In the present work he brings the subject up to date by surveying what has been done by others in all parts of the world and by recording the results of his own more recent observations. He shows for example how widespread among tropical crops is the association of mycorrhiza with the roots and considers that this is the reason that certain crops respond so markedly to cattle manure.

As most old gardeners know, a plant which is kept growing well by providing it with the most suitable conditions of soil and climate is seldom attacked by disease or pests. Sir Albert develops this idea and goes so far as to contend that insects and fungi are not the real cause of plant diseases but that they only attack unsuitable varieties or crops imperfectly grown. He considers that the policy of protecting crops from pests by means of sprays, powders, and so forth is unscientific and unsound as, even when successful, such procedure merely preserves the unfit and obscures the real problem—how to grow healthy crops. And the best way to grow healthy crops is to maintain the humus content of the soil. These views, as well as those on the administration of agricultural research which he includes in the book, will not receive universal acceptance. The author appears to realise this for he expresses the hope that the frank statement of his conclusions will lead to an equally free discussion and that new lines of thought will be opened up and effective action eventually taken.

The first part of the book considers general matters relating to the importance of soil fertility in agriculture. Part II deals with the Indore Process, including particulars of making organic composts and practical applications in respect of certain important crops (coffee, tea, sugar-cane, cotton, sisal, maize, rice, etc.). The

author then discusses green manuring, grassland development and utilisation of town wastes. In Part III health, indisposition and disease in agriculture is discussed and Part IV contains the author's views on present-day agricultural research.

There are three appendices: an account of compost manufacture on the Gandrapara Tea Estate in Bengal by J. C. Watson, the Manager; compost making at Chipoli, Southern Rhodesia, by Captain J. M. Mowbray; and a reprint of a paper read by Sir Albert Howard before the Royal Sanitary Institute on the manufacture of humus from the wastes of the town and the village.

The book is very well illustrated by photographs and diagrams and everyone, whether he accepts the author's views or not, will be glad to have in one book the considered opinions of one who has spent so much time (40 years) in the development of agriculture along practical lines.

THE COMPLETE GUIDE TO SOILLESS GARDENING. By W. F. Gericke. Third Printing. Pp. xvi + 285, 9 × 6. (London: Putnam & Company, Ltd., May 1940.) Price 12*s.* 6*d.*

In view of the numerous publications that have been put out on this subject lately the appearance of a further book on soilless gardening might seem redundant. It must be pointed out, however, that the treatment is here rather more detailed than in the case of previous works and is based on the author's own extensive experimental work.

The accounts of apparatus and nutrient solutions do not contain much that is fresh, but the later chapters describing planting technique and heating, lighting and aeration problems are of greater interest and should prove of help to growers. Deficiency symptoms and those resulting from excess of different nutrient elements are dismissed rather briefly.

It is for the more detailed instructions on the growing of specific crops that the book will be found most useful. The crops discussed cover a wide range of vegetables and flowers, including as some of the more interesting examples potatoes and root vegetables, flowers grown from bulbs and corms and a few woody perennials such as fuchsias and roses.

Apart from a very brief chapter on sand culture, which the author does not regard as a method of "soilless crop production," the remainder of the book is largely concerned with general considerations of production and economic possibilities.

VEGETABLE GROWING IN THE TROPICS. By L. H. Saunders, F.R.H.S. Pp. vii + 120, 7½ × 5. (Oxford: The University Press; London: Humphrey Milford, 1940.) Price 3*s.* 6*d.*

This little book will be found of great service to those in the tropics who have to maintain a supply of fresh vegetables. The

author has had experience of conditions in the Gambia and other parts of West Africa, in East Africa and India. In general, conditions in West Africa form the basis of the notes provided, but gardeners elsewhere should without difficulty be able to adapt the information to meet their own particular requirements.

After a brief introductory section dealing with general questions of cultivation, seed-sowing and the lay-out of a vegetable garden, the various crops are considered in alphabetical order. The cultural notes include advice on such matters as varieties, soil conditions, sowing, cultivation, harvesting, pests, etc., and what is so frequently omitted from books of this type, notes are provided on the preparation and cooking of each vegetable, including even the quantity that should be provided for each person. There is a short section also on the preservation of vegetables by bottling.

STARCH AND ITS DERIVATIVES. By J. A. Radley, M.Sc., A.I.C. Pp. x + 346, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Chapman & Hall, Ltd., 1940.) Price 22s.

This book is Volume Eleven of a series of monographs on applied chemistry prepared under the editorship of Dr. E. Howard Tripp, and, like all the works that have appeared in this series, it seeks to summarise recent progress in an important section of chemical industry.

The subject matter, which is divided into four main sections, deals in detail with the structure and reactions of starch, the manufacture of starch and starch products, the industrial application of starch and starch products, and the examination and analysis of starch and starch products. To supplement the text there is a comprehensive list of references at the end of each chapter.

The book can be thoroughly recommended to both the academic and the technical worker as a comprehensive survey of the literature on starch and its derivatives.

In Part II (Manufacture) the products dealt with include root starches (potato, cassava and sweet potato), cereal starches (wheat, maize and rice), soluble starches, glucose and maltose, ethyl alcohol and acetone, and dextrin and British gums. Of the innumerable uses to which starch is put in industry, most space is devoted to the question of its employment for adhesives and in the paper and textile industries. Other uses dealt with include the employment of starch for cosmetic and pharmaceutical purposes, as a filler in soap and insecticides, as a binding agent in explosives and matches, and for various food purposes. There are also chapters in this section on antiseptic agents and preservatives and on the preparation of enzymes used in the starch industry. Included in the last section is a series of some 50 microphotographs of starches, which should be of great assistance in identification.

METHANE. ITS PRODUCTION AND UTILISATION. By J. P. Lawrie, Ph.D., F.I.C.S. Pp. 66, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Chapman & Hall, Ltd., 1940.) Price 6s.

The mission of the writer of this little book, who is an honorary joint secretary of the Gas Traction Development Committee, is to convince the country of the advantages that would accrue by using its actual and potential reserves of methane as a fuel in internal combustion engines.

Methane in considerable quantities is given off in many coal mines when the pressure under which it is imprisoned in the coal is released. It is also found in various parts of the country associated with oil, one such source in Scotland yielding daily, it is stated, some 12,000,000 cubic feet of practically pure methane, equivalent to 60,000 gallons of petrol. Sewage treatment affords a further important source of supply. In addition there are other means of obtaining methane, for instance by separating it from coal gas and by the hydrogenation of coal, but these are in a different category as they involve the production of one fuel at the expense of another.

Though data for accurate calculation are lacking, the author considers it a reasonable assumption that methane from known possible sources, excluding those involving the consumption of an existing fuel, could supply "not less than 7 per cent. of the country's peace-time requirements of fuel substituting petrol."

Practical problems arising in connection with the use and handling of methane, including its compression and liquefaction and the question of containers are discussed.

Reference is also made to other possible applications, apart from its use in internal combustion engines, as for example the production of other organic compounds and of carbon black, and it is suggested that should methane be extensively produced in this country, developments in these directions might be expected.

USES AND APPLICATIONS OF CHEMICALS AND RELATED MATERIALS. Compiled and edited by Thomas C. Gregory. Pp. vi + 665, 9×6. (New York: The Reinhold Publishing Corporation; London: Chapman & Hall, Ltd., 1939.) Price 60s.

The author of this American work of reference is one of the editors of the *Condensed Chemical Dictionary*, the second edition of which was reviewed in this BULLETIN, 1931, **29**, 111, and is an expert on chemical marketing. The present compilation is founded on data already published in the *Oil, Paint and Drug Reporter*, and is intended as a guide to those concerned with the marketing of chemical products. A useful feature of the book is the inclusion of the names of the different products in the more important foreign languages. In many cases there are references to patents, mostly

British. The lists of applications of each material are probably almost exhaustive, and indeed in some cases their very length may limit their utility as it is not generally indicated which of the technical applications recorded are of established commercial importance.

THE NATIONAL PAINT DICTIONARY. By Jeffrey R. Stewart. Pp. 154, 12 × 9. (Stewart Research Laboratory, Franconia, Alexandria, Va., U.S.A., 1940.) Price $5.00.

This publication contains in a handy form a quantity of concise information concerning materials and processes that are of interest to the paint and allied industries. It is usefully illustrated with diagrams, photographs and charts, and contains a number of tables mostly relating to the properties or handling of materials used in the paint industries.

THE INDIGENOUS TREES OF THE UGANDA PROTECTORATE. By William J. Eggeling, B.Sc., Ph.D. Pp. xxii + 296, 10 × 8½. (Entebbe, Uganda: The Government Printer, 1940.)

Not many years ago the information available on the Uganda flora was so limited that the publication of anything approaching a complete list of trees indigenous to the Protectorate would have been out of the question. With the increasing amount of material that has become available for study, supplemented by Dr. Eggeling's own collections and field observations during the eight or nine years that he has been on the staff of the local Forestry Department, it has been possible to prepare the above work in which are described all the indigenous trees recorded from Uganda up to the end of July 1939. The magnitude of the author's task needs no emphasis and there can be no doubt of his success in producing a work of the greatest value both for routine work and as a basis for further study of the Uganda flora.

Ease of reference has been regarded as of foremost importance in the arrangement of the book, and the usual phylogenetic scheme has given place to an alphabetical arrangement of the families and of the genera and species within them. The determination of specimens is greatly aided by the detailed artificial keys to families, genera and species. With the description of each species the author cites numbered specimens, mostly of his own collecting; districts where the species is known to occur are listed and native names given where these are considered reliable. Botanical synonyms are only given in certain cases of confused identity. The numerous excellent photographs and line drawings included with the text add very considerably to the usefulness of the work; mention must also be made of the index to genera and species, the map of Uganda and the two glossaries—of botanical terms and of vernacular, common and trade names—which conclude the book.

BEETLES INJURIOUS TO TIMBER AND FURNITURE. Department of Scientific and Industrial Research, Forest Products Research Bulletin No. 19. Pp. 36, 9½ × 6. (London: His Majesty's Stationery Office, 1940.) Price 1s. 6d.

This Bulletin is based on one by Professor J. W. Munro issued as *Forestry Commission Bulletin No.* 9, the second edition of which appeared in 1932 but is now out of print. The original text has been revised and expanded by Dr. R. C. Fisher, of the Entomology Section of the Forest Products Research Laboratory, in consultation with Professor Munro, and in its present form is successful in giving in the short space of 36 pages a wealth of useful information on these important pests. They are dealt with under the headings: Longhorn Beetles; Pinhole Borers; Powder-Post Beetles; Furniture Beetles; and Other Timber Beetles (including the wood-boring Weevils and the Wharf Borer).

With each group the life histories are fully described and particulars are given of the type of damage done and the species of timber attacked where any preference is shown. Possible remedial and preventive measures that can be adopted in the different cases are also discussed.

The Bulletin is well illustrated with large-scale drawings and photographs of the beetles and also photographs showing up the distinguishing features of the damage characteristic of the various groups described.

The bibliography of selected references that follows the text will serve as a guide for more specialised study of any of the beetles concerned.

INSECT PESTS IN STORED PRODUCTS. By H. Hayhurst, F.I.C., A.M.I.Chem.E. Pp. xi + 83, 8½ × 5½. (London: Chapman & Hall, Ltd., 1940.) Price 15s.

This book presents a survey of the insects found in stored products, being based on information collected by the author in his wide practical experience of pest infestation in railway warehouses, but it would have been of still greater value if more attention had been paid to the results of previous workers, entomologists as well as chemists, in this field.

The purpose of the text is to describe the insects, giving information about their habits and the types of product in which they are generally found. Control measures are dealt with only briefly (in 5½ pages) and in a general way mainly from the point of view of preventing outbreaks. The question of control by fumigation and spraying is dismissed in a single paragraph.

The descriptions, which embrace insects predacious on the pests themselves, are arranged according to the general entomological classification of orders and families, but there are no descriptions

of these and the beginner has no guidance to the placing of a new find. There are also sections on the related groups of mites and false scorpions. The excellent photographs by Mr. Harry Britten (of which there are 132, the scale of magnification being given in all cases) should be of great help in the identification of the insects in question, and the beginner would be well advised to use these in the first instance and then check up the identification by the written description.

The 25-page " List of Substances and their Pests " which concludes the text will undoubtedly prove a most valuable asset, and is remarkable for the wide variety of the substances that are mentioned—from wheat, maize and cacao to such products as asparagus berries and dried rose petals. There is also an index of the pests described.

The bulk of the book appeared originally in the form of articles in the journal *Food*. Mr. T. W. Jones, editor of that publication, in a Preface, states that apart from the publications of the Pest Infestation Research Committee and the booklets issued by the British Association of Research for the Cocoa, Chocolate, Sugar, Confectionery and Jam Trades, " information upon the prevention and cure of insect damage has been exceedingly difficult to come by. Even more serious has been the complete lack of a practically useful description of the harmful pests." Mr. Jones, and presumably the author also, seem to have overlooked the valuable work put out by the Staff of the Stored Products Research Laboratory of the Imperial College of Science and Technology, in the form of semi-popular articles in various journals, of publications of the Empire Marketing Board, and of papers in the scientific periodicals. It will be sufficient here to mention just one of these, that by Mr. G. V. B. Herford on " The More Important Insect Pests of Cacao, Tobacco and Dried Fruit," published in this BULLETIN, 1933, **31**, 39, which had the avowed object of helping the " practical man " to identify the most common pests which attack these products.

MINERAL RESOURCES

ARTICLE

CANADA'S MINERAL RESOURCES IN RELATION TO THE WAR EFFORT*

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As contrasted with warfare up to the beginning of the present century, modern warfare—as illustrated by the War of 1914-18 and, to a still greater degree, by the present War—demands the mobilisation of the entire resources—economic (including mineral and industrial) as well as military—of the nations engaged.

From the close interrelation that now exists between a nation's war operations and its industrial development, it is evident that practically all the many minerals used in the industrial arts are of war importance, directly or indirectly, and that no definite line can be drawn between minerals that are essential for war and those that are not. There are, however, several minerals, without ample supplies of which a nation, even though strong in man-power, cannot hope to defend itself successfully. These minerals are usually classed as *essential* war minerals, although they are in reality *indispensable* war minerals ; they are not, however, limited to those from which armaments and munitions are actually made. Tungsten, for example, is used only in relatively small quantities, chiefly in making the high-speed tool steels necessary for high efficiency mass-production machining operations in munition factories, and is therefore listed as an essential war metal.

Iron still holds its long established position as the chief war metal, but it is no more essential than the manganese required in steel, and the nickel, chromium, cobalt, and molybdenum that, used in small proportions, give strength, toughness, hardness, resistance to shock, endurance, or other properties to the many steels used in war machines. Copper and zinc are essential for the making of brass cartridge cases and other munitions ; large quantities of zinc are used in galvanising and in paints, and copper is widely used for electrical and communication equipment as well as for shell-bands. Lead and antimony are essential for the making of bullets for small arms and shrapnel, and lead for the storage batteries so widely used in war as in peace. Aluminium has become

* Abridged, by kind permission of Dr. R. H. Coats, Dominion Statistician, from an article prepared for the *Canada Year Book*, 1940.

an essential metal, particularly for the building of aircraft, and magnesium is attaining importance for the same purpose. Platinum is valuable for electrical contact points and as a catalyser in the production of sulphuric acid for the manufacture of explosives. Tin and mercury are also essential, the latter being of special importance for the making of detonators for explosives.

Coal, though superseded by oil as naval fuel, is considered as the most important non-metallic war mineral. Petroleum—one of the recent war recruits—is, however, no less essential as the source of the liquid fuels that are vital to the movement of the naval, air, and highly mechanised land forces. Were it not for the lubricants produced from crude petroleum, present mechanised operations on land and sea and in the air would cease at once, and the supporting industrial machine could not function. Other non-metallic minerals usually classed as essential for war are sulphur, mica, asbestos, fluorspar, graphite, potash, magnesite, pyrite, phosphate, and iodine. There are many other minerals that, while actually as essential, are not so classed, in some cases because of widespread and abundant occurrence ; limestone, essential for the smelting of iron ore and for the production of other war minerals, is an example. Such seemingly unimportant war-purpose minerals as those used in glass-making are other examples, although, without glass lenses and prisms for range finders, anti-aircraft artillery and long-range naval guns would lose most of their effectiveness.

No nation is self-sufficient in the possession of natural resources from which to draw its full requirements of raw materials, even in peace-time, and all are less so in meeting the greatly expanded war-time demands for essential raw materials. This is particularly true of mineral resources. Deficiencies in native supplies must, therefore, be made good by purchases from other nations—and in war time from allied or neutral nations only. Large economic resources are, therefore, of vital importance in the waging of modern major wars in order to finance such purchases. The great war significance of economic reserves has been demonstrated by the fact that, immediately on the outbreak of the present War, all the Allied nations, including Canada, set up exchange control organisations with wide powers to conserve and build up the national foreign-credit position. This emphasises the importance of gold, the universally accepted medium of exchange, as an essential war metal, though not usually classed as such.

The contributions that can be made by a nation's mining industry to its war effort are thus of two kinds :

(*a*) The production at reasonable cost of those minerals that are essential for the manufacture of armaments, munitions, and other war supplies, as well as for normal civil needs.

(*b*) The creation of essential foreign credits by the production of gold and silver, and of other minerals, surplus to national needs, for export sale to neutral countries.

Development of Canada's Mineral Resources

The importance of mining in Canada's economy may be appreciated from the fact that it now ranks second among the great basic industries. The estimated output, valued at over $473,000,000 in 1939, was the highest on record, yielding first place only to agriculture. The Dominion now occupies a leading position among world mineral producers—in 1938, ranking first in nickel, asbestos, and platinum; second in radium; third in gold, silver, copper and zinc; and fourth in lead. These important minerals are produced mainly for export. In addition, Canada produces large quantities of coal, gypsum, petroleum, and many other minerals.

The attainment of such prominence in the mineral field, a development largely of the present century, is evidence of the wealth of the Dominion's mineral resources. It also shows ability to exploit these resources at the low costs necessary to increase export sales, particularly in the highly competitive export markets that have characterised the past decade. Moreover, all but a small portion of its present very substantial production of metals comes from ore deposits that have so far been found in two of its main physiographic divisions, the Canadian Shield and the Canadian Cordillera. Together, these comprise about two-thirds of the Dominion, but only relatively small portions have as yet been intensively prospected, and much has still to be geologically mapped. The various formations scattered over the vast extent of the Canadian Shield are remarkable for the useful minerals contained—copper, gold, iron, nickel, silver, platinum, cobalt, zinc, radium, chromium, graphite, mica, corundum, talc, feldspar, nepheline-syenite, and most of the other minerals that are used in the arts—the ore deposits ranging in extent to such major bodies as those now being worked at Sudbury, Noranda, Porcupine, Kirkland Lake, and Flin Flon. The Cordillera in British Columbia and Yukon is rich in lodes of gold, silver, lead, zinc and copper, and has extensive deposits of coal and other minerals, sustaining the reputation of its southern continuation in the western United States, Mexico and South America as a source of mineral wealth. In addition, the other three major physiographic divisions of Canada are rich in minerals. The Appalachian Highland of the Maritime Provinces, besides containing large deposits of bituminous coal, has yielded gypsum, salt, iron, gold, manganese, antimony, petroleum and natural gas; and of south-eastern Quebec, in addition to containing the world's largest known asbestos deposits, has yielded pyrite, chromite, copper, lead, zinc and gold. The Great Interior Plain of Western Canada contains Canada's greatest reserves of the mineral fuels, coal, petroleum, natural gas and bituminous sands, in addition to deposits of such industrial minerals as salt, gypsum, sodium sulphate and refractory clays. Even the St. Lawrence Lowland, essentially an agricultural and manufacturing area, yields non-metallic minerals

of great industrial value, including salt, gypsum, petroleum and natural gas.

The foregoing brief statement of the diversity of the minerals found in Canada, together with the record of continued growth in mineral production in the past decade, indicates the very substantial contribution the mineral industries are in a position to make to the present war effort.

During the fifty-four years that intervened between Confederation and the War of 1914-18, Canada's attention was devoted almost entirely to the solution of the numerous problems related to the political and economic development of the new Dominion. Its mineral resources were accordingly explored and developed primarily on the basis of furnishing the growing mineral demands of such a peace-time programme, modified by the fact that necessary supplies were conveniently available from the United States. They were also developed for the production of such minerals as could be sold in export markets to provide credits to finance imports of essential manufactured goods and supplies not yet produced in Canada.

In 1913, marking the close of the era of rapid western settlement and its accompanying railway expansion, the Canadian mining industry recorded its peak pre-war annual output value of $145,635,000, of which metallic minerals represented 46 per cent., the mineral fuels 28 per cent., and the industrial minerals, including structural materials and clay products, 26 per cent. All but a relatively small portion of the metals were exported. Silver was the leading metallic mineral in output value, followed by gold, nickel, copper, lead, iron, cobalt and zinc. Of the four non-ferrous base metals—copper, lead, zinc and nickel—only lead was produced in refined form, Canadian requirements of the others in refined form being imported. Of the non-metallic minerals then produced, coal, asbestos and gypsum were the most important, the last two being very largely sold for export.

The development of Canada's mineral resources up to the commencement of the War of 1914-18 had, therefore, no relation to war requirements, except in the production of nickel matte for export, nickel then being considered largely as a war metal because of its important use in making armour plate. The significant development in the Dominion's mineral industry during the five years of the War was the establishment of domestic metal-refining facilities, the production of refined zinc and refined copper at Trail, B.C., commencing in 1916, and of refined nickel at Port Colborne, Ontario, in 1918. Owing to the pressure of war demands at high prices, substantial increases in the production of nickel, copper, lead, zinc, pyrites, molybdenite, chromite and asbestos were recorded in the war years. However, it was the large growth in mining operations of the period of prosperity which ended in 1929, and, more particularly, in the six years of subnormal mineral prices

(except for gold) that followed the low point of the depression in 1933, that established the great strength of the Dominion's mineral position in support of the present war effort.

Not only is the Canadian mining industry able to produce very important essential war minerals in greater quantities than ever before, but it can do so profitably at prices very much lower than those that had to be paid during the War of 1914-18. Thus, a very valuable indirect contribution is being made to the conservation of the Allied economic reserves. In addition, by reason of the remarkable expansion in gold mining in recent years the industry is in an exceptionally strong position to add directly to those economic reserves.

CANADA'S MINERAL PRODUCTION IN 1918 COMPARED WITH 1939

Mineral.		Quantities. 1918.	Quantities. 1939.*	Values. 1918. $'000.	Values. 1939.* $'000.
Metallics					
Gold	*fine oz.*	699,681	5,095,176	14,464	184,145
Silver	,,	21,383,979	23,116,861	20,694	9,360
Copper	*short tons*	59,385	304,050	29,251	60,860
Nickel	,,	46,254	113,053	37,003	50,920
Lead	,,	25,699	194,189	4,754	12,308
Zinc	,,	17,542	197,267	2,862	12,108
Platinum metals	*fine oz.*	1,949†	284,304	71‡	9,422
Other				5,522	3,531
		Total, Metallics		114,549§	342,654
Non-Metallics					
Coal	*short tons*	14,977,926	15,519,464	55,193	48,258
Petroleum	*barrels*	304,741	7,838,310	885	10,353
Natural gas	*M. cu. ft.*	20,140,309	35,394,087	4,351	12,539
		Total, Fuels		60,429	71,154¶
Industrial					
Asbestos	*short tons*	158,259	364,472	8,971	15,859
Gypsum	,,	152,287	1,408,188	823	1,923
Salt	,,	131,727	424,500	1,285	2,487
Sulphur	,,	154,269	210,704	1,705	1,668
Sodium sulphate	,,	nil	71,453	—	627
Other				4,409	2,461
		Total, Industrial		17,193	25,025
		Total, Non-Metallics		77,622	96,179
Clay Products and other Structural Materials				19,131	34,274
		Grand Total		211,302	473,107

* *Subject to revision.*

† *Largely recovered at International Nickel Company's New Jersey refinery. This figure does not include the recovery in Great Britain from the Mond Nickel Company's nickel matte.*

‡ *Value of* 689 *fine oz. of platinum.*

§ *Includes the value of platinum from placer deposits, but not that of platinum from nickel matte.*

¶ *Includes peat.*

Essential War Minerals produced in Canada

In the first month of the present War the large Canadian producers of copper, lead and zinc entered into a one-year agreement (with the privilege of renewal) with the British Government to supply 210,000 short tons of refined copper, and the entire output of refined lead and zinc surplus to Canadian domestic requirements, at prices approximating the low prices then prevailing, with adjustments for shipping costs and for possible rises in production costs. A substantial portion of the British requirements was thereby assured at prices very much lower than were paid during the War of 1914-18.

Copper.—Copper is usually considered as the second most important of the war metals, more by reason of the large quantities required in application of the ordinary commercial uses to war needs than for its specific military uses. Canada has greatly strengthened its position as a copper producer since the close of the War of 1914-18. The 1938 production of 285,625 tons represented 13·1 per cent. of world output, and ranked the Dominion as the third largest producer. Preliminary figures for 1939 show a further increase to 304,050 tons. Moreover, this large growth has been brought about chiefly by the discovery and development of new deposits across the Dominion. While the 1938 output from British Columbia, the largest source in 1918, was little reduced, the production from the deposits near Sudbury, Ontario, the present largest source, was almost seven times that of 1918. Large quantities are obtained from new producers, including Noranda, Waite-Amulet, Normetal, and Aldermac, in Quebec; and Flin Flon and Sherritt Gordon in Saskatchewan and Manitoba. In addition to the strength derived from such broadening of sources of production the Dominion is now equipped with two large copper refineries at Copper Cliff, Ontario, and at Montreal East, Quebec, with a combined rated annual capacity at present being increased to 245,000 tons of refined metal. While in 1918 the amount of copper refined in the original refinery at Trail (since closed) amounted to only 3,809 tons, or little more than 6 per cent. of the copper produced in that year, the production of refined metal in 1938 amounted to 227,240 tons or to almost 80 per cent. of the year's total copper output.

As already pointed out, shipments of the very substantial quantity of 210,000 tons of refined metal—more than double the entire Canadian production in 1928—are to be made in the first year of its contract with the British Government. Furthermore, the industry, by its ability to sell this copper profitably at the pre-war price of slightly over 10 cents per lb., or nearly 16 cents less than the pegged price of 26 cents per lb. paid by the Allies during the latter part of the War of 1914-18, is also making a very substantial contribution to the conservation of Allied financial resources.

Lead.—From its relatively unimportant position as a lead producer during 1914-18 Canada has advanced until it now ranks fourth among world sources of the metal. Its all-time peak production of 209,464 tons in 1938, almost ten times the average annual output of the four years of war demand from 1915 to 1918, comprised about one-ninth of the world production for the year. Moreover, there has been a substantial growth of 28 per cent. in the annual production in the period of low prices that has prevailed since 1929. This has come chiefly from the Sullivan mine in southern British Columbia. (The refinery at Trail has a rated annual capacity of 205,000 tons of refined lead.) In view of the fact that most of the output is sold in highly competitive export markets, largely in the United Kingdom, this record of increasing production for such sale indicates the relatively low producing costs in the Canadian lead industry.

Canada will therefore contribute large quantities of lead at low cost to the present war emergency. As in the case of copper, the economic benefits of this low-cost supply to the Allies may be appreciated by comparing the pre-war price of little more than 3 cents per lb. of refined metal with the average price of nearly 8½ cents per lb. received by Canadian producers during the last four years of the War of 1914-18.

Zinc.—Contrasted with the insignificant position of zinc in 1914 when the entire output comprised an estimated 3,623 tons contained in concentrates exported as such, the 1938 production of 190,753 tons—90 per cent. in refined form—ranked Canada as the third largest world producer. The annual production has almost doubled in the period of depressed prices since 1929, that of 197,267 tons (preliminary figures) in 1939 being a new all-time peak. About 75 per cent. of Canada's zinc comes from the Sullivan mine in southern British Columbia, probably the world's greatest zinc mine, and 20 per cent. from Flin Flon in Manitoba and Saskatchewan. Each mine has its own associated refinery. The rated annual capacities are 145,000 and 40,000 tons respectively, or a total of 185,000 tons of refined zinc.

Domestic requirements normally absorb only a relatively small portion of the production. As the production can be substantially increased, the Canadian zinc-mining industry can furnish large supplies for war purposes. Moreover, it can do so profitably at the pre-war price of about 3½ cents per lb. for premium zinc which approximates the price that the principal producers have agreed to accept from the British Government. The war position of the Canadian zinc industry may be determined by comparing its 1939 production of 197,267 tons averaging 3·1 cents per lb. in value, with its production in 1918 of 17,542 tons, the average value of which was 8·1 cents per lb.

Nickel.—Canada's extensive nickel-ore deposits near Sudbury are the present source of about 85 per cent. of the world's nickel,

just as they were the principal source of nickel during the War of 1914-18. Production has, however, been greatly increased by reason of the increasing industrial uses of the metal, the peak peace-time production of 112,452 tons in 1937 being nearly 2½ times that of 1918 when Great War requirements were at their maximum. The outstanding development since 1918 has been the increased production of refined metal, the refinery at Port Colborne, Ontario, which had an output of only 1,204 tons in 1918, now having an annual capacity of 75,000 tons of refined nickel. The output of refined metal in 1938 was 62,141 tons, or almost 60 per cent. of the year's total production of Canadian nickel.

The Canadian nickel producers are, therefore, in a position to provide ample supplies of nickel, both in refined and unrefined forms. Moreover, they can do so profitably at prices much below those that were paid during the War of 1914-18. This is indicated by the fact that the value of the 1939 production, estimated at 113,053 tons, largely refined metal, averaged 22½ cents per lb., compared with the corresponding average value of 36⅝ cents per lb. for the entire output, almost wholly in unrefined form, for the four years from 1915 to 1918 inclusive.

Iron.—The outstanding development in Canadian mining in 1939 was the resumption of production of iron ore in Ontario—at the New Helen mine in the Michipicoten district at the north-east corner of Lake Superior—under the encouragement of an Ontario Government iron bounty. The deposits contain an estimated 100,000,000 tons of siderite ore carrying about 36 per cent. iron. The ore is being beneficiated at the mine, the resulting sinter carrying about 53 per cent. iron. Shipments were commenced in the latter part of the year to the blast furnace at Sault Ste. Marie, and are anticipated to be on the scale of about 300,000 tons annually.

Another significant development, in its bearing upon the reduction of the present Canadian dependence upon outside sources of iron ore, was the discovery in the winter of 1937-38 of large deposits of high-grade hæmatite ore, containing from 51 to 60 per cent. iron, at Steep Rock Lake, about 135 miles west of Port Arthur. Exploration and development have since been in progress. The present indications are that this is likely to prove one of Canada's most important mineral discoveries in recent years.

While of relatively small immediate importance in relation to the present war effort, these developments have a large potential significance in conserving Canada's exchange position by reducing foreign expenditures for the imported iron ores now used in Ontario's blast furnaces.

Platinum Group Metals.—Canada's production of platinum recorded an all-time high of 161,326 fine oz. in 1938. Refining is carried out for the most part in England, and the Allies are thus assured of a large part of the available world output. During the last four years of the War of 1914-18 the reported Canadian output

averaged only 806 oz. per year, and was almost entirely refined in the United States.

Cobalt.—At one time the world's leading producer of cobalt, chiefly as a by-product of the production of silver in northern Ontario, Canada now ranks third, its production in 1938 amounting in terms of metal content to 229·5 tons. This production can be increased, and ample refining facilities are available for the final treatment of both domestic and imported ores.

Molybdenum.—There was a substantial production of molybdenite, the principal ore, in Quebec during the years 1914-18, chiefly from a deposit at Quyon on the Ottawa River, but this ceased entirely in 1929 after a period of small and intermittent operation. The Quyon deposit is now (1940) being reopened. Several other deposits have been found across the Dominion, and the more promising are under development.

Aluminium.—Canada has no known commercial deposits of bauxite, the most important ore of aluminium, but, because of abundant water-power resources, has become one of the world's most important producers of that essential war metal, ranking third in 1938. Production figures are not available for publication, but the quantities exported, comprising the great bulk of the output, give a fair indication of Canada's increasing importance as a producer of aluminium. Thus the exports of 64,724 tons in 1938 were 70 per cent. higher than in 1929, and almost 500 per cent. higher than in 1918.

The productive capacity of the Canadian aluminium-producing plants is at present being substantially increased; it has been announced recently (February) that the entire output, surplus to domestic requirements, is now under contract to the British Government.

Coal.—Though possessing an abundance of coal reserves, Canada has always drawn a large part of its requirements from foreign sources, the highly industrialised sections of central Canada being much more convenient to the nearby deposits south of the Lower Lakes than to the domestic mines. This dependence upon foreign coal supplies has been materially lessened since the War of 1914-18, and particularly in the latest ten years, with the granting of Dominion Government assistance to enable Canadian coal to meet the competition of such foreign coals in central Canada. In addition, there has been a large diversion in foreign sources of anthracite requirements from the United States to the United Kingdom, which is of special economic significance in the present war emergency.

Petroleum.—The recent development of quantity production of crude petroleum in the Turner Valley field of Alberta has already materially reduced Canada's almost complete dependence upon foreign sources of supply of crudes. The Dominion's production, chiefly from Alberta, recorded an all-time peak of 7,838,310 barrels in 1939. Were it not for the restrictions on marketing of Turner

Valley crude imposed by transportation costs and low prices of competing foreign crudes during the year the production would have been substantially greater. While this 1939 output was greater than the entire quantity of crude refined in Canada in 1918, it represented only 19 per cent. of the crudes so refined in 1938, and a smaller percentage of the total Canadian petroleum supply for the year, which included large quantities of imported refined products as well as crudes imported for refining.

Asbestos.—As the world's chief source of chrysotile asbestos, Canada can provide ample supplies from south-eastern Quebec of this easily spun type of the mineral for essential war purposes, including brake-linings and high temperature insulation.

Magnesite.—There is a large production of magnesitic-dolomite for refractories in Quebec, and deposits of limestone containing brucite, another magnesium ore, have recently been discovered in Ontario and Quebec. Large magnesite deposits in southern British Columbia are also being developed.

Mica.—The Dominion's mica position is indicated by the fact that it has been a continuous producer of mica, almost wholly of phlogopite or amber mica, for over half a century, chiefly for export.

Other Essential War Minerals.—While occurrences of ores of such important essential war metals as antimony, tungsten, chromium, and mercury, as well as of other essential non-metallic minerals have been found in Canada, and these have in some cases been worked, domestic requirements have been obtained almost entirely from foreign sources. From the number of these occurrences there is reason to anticipate that careful prospecting will disclose important commercial deposits of many of these minerals. The production of high-grade electrolytic antimony from lead-silver smelter residues has recently commenced in British Columbia.

Gold and Silver for Foreign Credit

Gold.—In recent years mining attention in Canada has been very largely concentrated upon gold. Annual production, mostly of lode gold obtained in increasing quantities from deposits found in the Canadian Shield, has, with few exceptions, risen each year since the close of the War of 1914-18. The preliminary figure of 5,095,176 fine oz. in 1939 is 7·8 per cent. higher than the previous all-time peak of the preceding year. Valued at $184,144,756 in Canadian funds, the 1939 output represented immediately available foreign credits in the United States, at $35 per fine oz., of $178,331,160. This is more than ten times the average annual foreign credits made available by Canadian gold mines for the four years from 1915 to 1918. Not only is the present gold contribution to the Dominion's economic strength so much greater than during the War of 1914-18, but it is much more essential. For example, under the provisions of the present United State neutrality legislation, gold or its equivalent is indispensable in order that the

fullest possible advantage can be taken of the huge industrial organisation of the United States for the production of urgently needed war equipment.

Silver.—Although silver is, because of its present low price, produced in Canada chiefly as a by-product of the treatment of ores mined primarily for the production of lead, nickel, copper, zinc, gold and radium, the Dominion ranks as the third largest world producer. The annual production in 1939, estimated at 23,116,861 fine oz., was 4 per cent. higher than in 1938 and about 6 per cent. greater than the average output for the last two years of the War of 1914-18, but its value was less than half. Nevertheless, an annual contribution of $9,359,553, as in 1939, is a substantial one towards the support of the national economic reserves.

Conclusion

It is evident that Canada's mining structure, built up on the basis of peace-time needs, is capable of giving strong support to the present war effort. Particularly is this the case with the non-ferrous base metals, because of their vital importance in the military operations of modern mechanised war. Gold, however, is no less essential on the equally important economic front. In 1914-18 Canada was an important producer of nickel, although in unrefined form, but produced comparatively little copper, lead and zinc, and of these only lead was produced in refined form. Its role as a world gold producer was then a small one. Since that time, however, its annual production of nickel has more than quadrupled, and the Dominion now holds a leading position, both as a producer and exporter of copper, lead, and zinc, also of gold and platinum. It is fully equipped with huge metallurgical refining plants, one each for lead and nickel, and two each for copper and zinc, and all can be increased in capacity, as required, at relatively small capital outlay.

During the War of 1914-18 the world shortage of producing capacities of the essential base metals, and the urgency for larger supplies, forced prices to abnormally high levels. The large expansion in Canadian output together with the impressive dividend records of the producers during the past ten years of low prices can be accepted as evidence of the favourable mine-operating conditions that exist to-day in Canada. The Dominion's large producers of copper, lead and zinc are passing the advantages of their low costs of production on to the British Government for war purposes by agreeing to furnish the larger part of their outputs at virtually the prices that prevailed just prior to the War. On their purchases of these three metals under these agreements the British Government will pay possibly from $75,000,000 to $90,000,000 less per year than for similar purchases in 1918.

Two recent events in Canadian mining give additional strength to the industry's war position. The first relates to the discovery of high-grade hæmatite iron ore in western Ontario and the resump-

tion, after 16 years, of the production of iron ore in Ontario at the New Helen mine. The second is the development of the Turner Valley crude petroleum field of Alberta. While of no immediate strategic importance, because of the unrestricted availability of ample supplies from conveniently situated United States reserves, they will increasingly strengthen the Dominion's financial position.

At the outbreak of hostilities in September, 1939, the Dominion already occupied a strategic position as a major producer of highly essential war minerals. With its capabilities for increasing expansion under the pressure of war demand, the Canadian mining industry can be expected to play its full part in the present war effort, both in providing minerals essential for military and civil needs and for the support of the economic front.

PROGRESS IN COLONIAL MINERAL INDUSTRY

Comprising periodic statements on mining and geological activities received from Government Technical Departments overseas.

BRITISH GUIANA

The following reports, prepared by the Director of the Geological Survey, have been received from the Commissioner of Lands and Mines. The first covers the last six months of 1939 and publication of this has been unavoidably delayed. The second covers the first six months of 1940.

Report for the half-year ended December 31, 1939

The Director, Mr. S. Bracewell, continued the survey of the area between the Aremu and Aranka goldfields in the Cuyuni River district. Workable gold deposits were found to occur in gullies draining areas of volcanic rocks near Waikuri Rapids, and to the north-west of Aremu Mine.

The volcanic rocks form belts of rugged country attaining a height of about 1,000 ft. above sea-level; these ridges are separated by flat areas of white sand which occurs as the remnants of a dissected flat about 450 ft. above sea-level. The mapping of these areas indicates that the white sand belts represent old channels or estuaries of a formerly extensive river system; the distribution of the diamond deposits and of many of the gold deposits is closely related to this old drainage system.

A brief visit was paid to Aranka and Aurora where alluvial and quartz milling machinery has recently been installed by American and Canadian companies.

During the second half of 1939 Dr. Bryn Davies completed the survey, commenced earlier in the year, of an area of some 450 sq. miles in the upper Mazaruni district. The area includes the important Tamakay and Issineru goldfields and some diamondiferous

ground. The gold deposits are associated with a granite contact which has now been mapped for a length of 30 miles, and it is anticipated that the publication of the report and maps will lead to increased prospecting activity in the areas indicated as favourable for the occurrence of gold-bearing quartz veins. The auriferous belt is interrupted in the west, towards the Kaieteurian escarpment, by the Werushima Hills, a 2,000 ft. range of rugged gabbro country beyond which the local prospector has had difficulty in penetrating. Gold and diamond indications were found here and an easy route has been cut to encourage further development.

An important result of the survey has been the discovery of a trough of low-lying country connecting the Mazaruni and Cuyuni Rivers west of the Werushima Hills. Further survey work will be required, but it appears probable that there is a feasible road route of 25 or 30 miles on level ground which would enable the present government-operated transport service in the Mazaruni to be extended to develop the upper Cuyuni and Wenamu districts on the western borders of the Colony.

MINERAL EXPORTS

	1937	1938	1939
Gold (*oz.*)	39,047	39,728	38,473
Bauxite (*tons*)	300,707	376,368	476,014¼
Diamonds (*carats*)	34,556	33,508	33,352

Gold.—During the year 1939 8,272 oz. of gold were recovered by dredging in the Mahdia River, and the remainder of the production was from small alluvial and quartz mining operations.

The machinery recently installed by the Aranka Mining Co., referred to in previous reports, commenced work in the Sir Walter Creek, Cuyuni River, late in December. The small quartz milling plant recently installed by a Canadian concern in the Aurora area, Cuyuni, is being used for the purpose of prospecting gold-quartz occurrences in the area.

A Canadian mining company is installing a scraper and washing plant in the Manikuru, a tributary of the Barima River, North-West District. Commencement of operations during the next quarter is anticipated.

Diamonds.—With the object of assisting this declining industry the royalty payable on gems has recently been reduced from 50 cents (2*s.* 1*d.*) to 15 cents (7½*d.*) per carat.

Bauxite.—The construction of the railway bridge by the Demerara Bauxite Company across the Demerara River referred to in a previous report has been completed. There are no other developments to record.

Mineral Oil.—The preliminary seismic survey of the Courantyne-Berbice district carried out on behalf of the Central Mining and Investment Corporation has been completed. It is understood that the question of putting down a geological exploration borehole is now receiving consideration.

Manganese.—Applications have been received for permission to

investigate the manganese deposits recently discovered in the North West District. No permission has as yet been granted and the area is still reserved from staking. The outbreak of hostilities in Europe has enhanced interest in these deposits, and it is anticipated that the search for new deposits in the Western Hemisphere may be intensified.

Other Minerals.—The possibility of the occurrence in the Colony of quartz crystals suitable for piezo-electrical purposes is receiving the attention of the Geological Survey.

Report for the half-year ended June 30, 1940

The scheme for the geological survey of a portion of British Guiana, which has been financed from the Colonial Development Fund, is almost completed. Owing to a severe illness Mr. D. W. Bishopp left the Colony in September 1939, and on July 6 Dr. D. A. Bryn Davies took up a temporary appointment with the Demerara Bauxite Company prior to returning to the United Kingdom. No field work was undertaken during the first half of 1940 and the period was spent on the examination of the rock collection and the compilation of reports and maps. The question of continuation of the geological survey is being considered.

Mineral Exports.—Exports for the first six months of 1940 were: gold, 14,555 oz.; bauxite, 240,335 tons; diamonds, 10,558 carats.

Gold and Diamonds.—The decrease in gold and diamond production as compared with the corresponding period of 1939 is largely attributable to the severe drought which was experienced in the Colony during the first half of the year as the consequent shortage of water handicapped alluvial operations. Transportation along the rivers was extremely difficult, and this has delayed the installation of the machinery in the Manikuru area referred to in the previous report.

Interesting developments are taking place at Aurora, a locality some 120 miles up the Cuyuni River. As stated in previous half-yearly reports, prospecting has been proceeding in this area since the beginning of 1938. This was first directed to the sampling of dykes of gold-bearing quartz porphyry which traverse the phyllites. Good values were found in the decomposed upper portion of the porphyry, but on reaching the solid rock at a depth of 30 to 50 ft. the gold content became too low to be of commercial interest.

Attention is now being directed to a broad mineralised zone of brecciated ferruginous quartz located on a 300 ft. hill. Good gold values were found in the outcrop, and a sample taken by Mr. Bracewell in November last over a width of 15 ft. of the outcrop yielded gold equivalent to 1 oz. 11 dwts. per short ton when crushed and panned. Since then a good deal of surface and underground exploration has been carried out and in March 1940 a new company, the Cuyuni Goldfields, Ltd., was formed. A mill capable

of dealing with 50 tons per day is now being installed on the property. An examination of the property was made recently by Mr. B. W. W. McDougall, a Canadian consultant.

The operations of the dragline excavator and floating washing plant which were commenced in the Aranka goldfield in November last have been abandoned, but the cause of the failure of these operations has not been disclosed. The plant was somewhat similar to that described by S. A. Westrop (" Alluvial Mining with Shovels and Draglines," *Min. Mag.*, March 1938) as working in the Pampana River, Sierra Leone. The dragline was mounted on caterpillars and operated by steam power. The washing plant, which was mounted on an old dredge hull, consisted of a hopper, large trommel, concentrating tables with expanded metal riffles, and two large sluices. The tables were discharged at the stern and there was no tailings elevator. The stream to be worked, the Sir Walter, was about 30 ft. wide, with much wider flats. The intention appears to have been to work the stream bed, the dragline proceeding upstream along the bank followed by the washing plant. The writer paid a brief visit to the property during the final stages of the erection of the plant and formed the opinion that the dragline could not be successfully operated under these conditions. The chief difficulty anticipated was that of maintaining a working face and pit in the bed of the stream deep enough to enable the bucket to clean up the pay gravel over a sufficient width. As fast as the overburden was excavated fresh sand would be washed into the pool from the creek and from the tailings.

Other difficulties confronting operations of this type are :

(*a*) deeply buried logs, the extraction of which causes delays ;

(*b*) large tree roots ; for instance, the huge buttresses of mora trees, which are a characteristic feature on river flats in this Colony ;

(*c*) the sticky clay overburden which is often difficult to discharge from the bucket ;

(*d*) the sticky clay which underlies or forms part of the pay gravel and requires puddling ;

(*e*) cemented gravels which the bucket cannot pierce ;

(*f*) the fluctuating water level which may rise well above the river flats during heavy rains.

Similar difficulties, of course, are met with and overcome during dredging operations, but they appear to present a more serious obstacle to the dragline excavator.

Bauxite.—Owing to the increased demand for aluminium the local bauxite industry has continued to expand. Engineers of the Berbice Co., Ltd., a local subsidiary of the American Cyanamid and Chemical Corporation, are carrying out further investigations in connection with the bauxite deposits in the Berbice district. Shipment of the ore presents some difficulty owing to a shallow bar at the mouth of the river.

Mineral Oil.—Machinery for the drilling of a bore-hole for geological exploration in connection with the petroleum investigations by the Central Mining and Investment Corporation in the Berbice District is already in the Colony and the work will be commenced as soon as the recently enacted legislation relating to this industry has been ratified.

Manganese.—No exclusive permission to prospect the manganese deposits of the North West District has as yet been granted.

GOLD COAST

The following report on the work of the Geological Survey for the half-year ended June 30, 1940, has been received from the Director.

A detailed geological survey of an extensive area around the gold mines in the Konongo district was completed and also surveys of the surface and underground workings of the mines.

Investigations were also made of the workings of gold mines and prospects in the Tarkwa and Prestea districts, of the Nsuta manganese deposits, and of the alluvial workings in the Birim diamondfield.

The country between Agogo, Kwahu Tafo, Kete Krachi, and Atebubu was geologically mapped and prospected, and traverses were made in the Axim, Sekondi, Cape Coast, Saltpond, Winneba, Obuasi and Bekwai districts.

The work of the Water Supply Section was continued with the help of temporary foremen in the Dagomba and Mamprussi districts of the Northern Territories.

Diamonds.—Interesting new developments from the geological standpoint are the opening up of a new deposit close to the Birim River, south-east of Ochereso, the working of high-level gravels at various places, and the discovery of diamonds in weathered bed-rock at Atiankama. Other deposits of the Ochereso type are likely to occur in the Birim valley above the Pra confluence. To locate them, the ground on both sides of the Birim for a distance of 2-3 miles should be prospected, particularly where there are Birim terrace gravels breached by small streams.

A very important development in treatment is the successful use by one company of grease-tables and ball-mills for recovering the diamonds from the concentrates. As a result hand-picking has been almost eliminated and the very small diamonds which previously were very difficult to collect are now being recovered. There has also been a marked increase in efficiency in working and transporting the gravel.

Gorceixite.—In 1937 the writer found in the gravels of the Bonsa river, south of Tarkwa, a few pellets of a mineral which proved on investigation by the Imperial Institute to be the rare mineral, gorceixite, which previously was known to occur only in Brazil. Since then he has found fragments of the same mineral in

concentrates from the diamondiferous gravels of the Birim river and Sierra Leone. The specimens from Sierra Leone were the subject to a very careful chemical and petrological study by the Imperial Institute.

Mica.—A preliminary survey of the Cape Coast, Saltpond and Winneba districts, in which occurrences of mica are plentiful and favourably situated, revealed that the bulk of the mica exposed at the surface is of relatively small size and of poor quality. Very large quantities of scrap mica could be obtained, however, and also some 2 × 1 in. mica of fair quality.

Asbestos and Platinum.—Occurrences of asbestos in serpentine were discovered by the Department at Cape Three Points, but a careful search of the locality indicated that they appear to be too small to be of economic importance. A mineralised rock at Axim assayed 2½ grains of platinum per ton.

Water Supply.—In Dagomba the old dam at Tamale was reconditioned and the large dam at Yendi completed. Progress was also made in the provision of ponds, wells and biligas. Work is now being mainly concentrated on biliga construction in the Karaga-Gushiago district and in maintenance and improvement of works previously constructed.

Several wells were constructed in the Mamprussi district and two weirs and some wells are under construction.

Publications.—*Bulletin No.* 11, on the Geology of the Gold Coast and Western Togoland and a geological map of the Tarkwa goldfield and Nsuta manganese-ore deposits on a scale of 1 : 25,000, have been completed and issued.

A report on the Accra earthquake was completed for publication, and reports on the Tarkwa goldfield, the diamond deposits of the Gold Coast, and analyses of Gold Coast rocks and minerals are in course of preparation.

MALAY STATES (FEDERATED)

The following data for the second quarter of 1940 have been compiled from returns furnished by the Chief Inspector of Mines.

PRODUCTION OF TIN-ORE
(April to June 1940)

State.	Metal content. (*Long tons.*)	Value. (£.)
Perak	10,874	2,767,244
Selangor	5,949	1,516,467
Negri Sembilan	674	172,319
Pahang	750	191,438
Total	18,247	4,647,468

Other minerals produced were: gold, 8,367 troy oz.; coal, 213,254 tons (all from Selangor); china clay, 116 tons; haematite, 263 tons (all from Perak); wolfram, 5 tons; scheelite, 13 tons; and amang, 1,456 tons.

MALAY STATES (UNFEDERATED)

Johore

The following progress report on mining in the State of Johore during the second quarter of 1940 has been compiled from a statement submitted by the Acting Warden of Mines.

Tin Ore.—The production of tin ore continued to be regulated by Tin Restriction and can only correspond to the permitted quota release plus an amount of tin ore sufficient to bring the stocks held on the mines to the full amount permitted under the International Tin Restriction Agreement. Exports cannot be greater than the permitted quota release for each quota period, which corresponds to a quarter of a year.

Exports of tin ore from all sources during the period under review amounted to 423·73 tons, valued at \$730,179·77 as compared with 306·10 tons, valued at \$476,598·12, during the first quarter of 1940.

The proportion of the total exports of tin ore from mines owned or managed by Europeans was 60·8 per cent. during the second quarter of the year as compared with 50·07 per cent. during the first quarter.

Iron Ore.—Exports of iron ore for April amounted to 51,341·60 tons, for May 60,476·84 tons, and for June 48,879·65 tons, making a total export of 160,698·09 tons valued at \$803,490·45. The exportation of ore from the East Coast was resumed during April, and from Endau the tonnage exported amounted to 50,663·90. From Batu Paht (West Coast) 110,034·19 tons were exported.

Bauxite.—The Kim Kim Mine, which is situated near Pulau Nanas on the south coast of Johore, was not operated during the quarter. From other mines the bauxite exported amounted to 15,175·05 tons, valued at \$75,875·25, the whole of which went from Batu Pahat on the west coast.

Gold.—There was no production of gold during the period under review.

NIGERIA

The following information covering the first six months of 1940 has been supplied by the Chief Inspector of Mines.

Mineral Production and Exports, January-June 1940

	Production.	Exports.
	Tons.	*Tons.*
Tin ore . . .	8,014	5,858*
Columbite . .	195·7265	100
Wolfram . .	59·5306	73·2428
	Troy oz.	
Gold (900 fine) .	11,523·75	—

* *These figures include* 248·5 *tons of the* 1939 *quota and* 221 *tons in advance from the quota of the third quarter* 1940. *In addition there was a special shipment from stocks of* 210 *tons.*

Tin.—As a result of additional special shipments of cassiterite from stock, Nigeria commenced the year 1940 with an excess carry-over from 1939. The Statistical Bulletin of the International Tin Research and Development Council showed the excess to have been 2,567 tons metal. During the first quarter of 1940, when the quota was 120 per cent., a certain amount of the 1939 excess was written down by off-setting quota tonnage against special shipment tonnage, but approximately 96 per cent. of Nigeria's quota for the first quarter was produced. The quota for the second quarter was 80 per cent., and the actual tonnage of ore shipped exceeded that percentage by 400 tons metal content. The production also exceeded the quota percentage by approximately 300 tons metal content. The position at the end of the first six months of 1940 was that Nigeria had actually shipped over 76 per cent. of the permitted quota for that period and written down the equivalent of approximately 1,600 tons metal of the 1939 excess.

Gold.—The production during the first two quarters of 1940 showed a decrease of 1,000 oz. compared with the same period last year.

Columbium.—The export of columbite was resumed during the first quarter of 1940, but none was shipped during the second quarter. There are ample stocks to meet any demand.

Tungsten.—The shipment of wolfram showed a decrease of some 40 tons as compared with the first six months of 1939. There is reluctance to equip properties for the production of a mineral with such a variable price.

SARAWAK

The Chief Secretary reports that the production of gold for the period March 1 to May 31, 1940, was 3,323 fine oz., of which 36 oz. came from the Kuching District and the remainder from the Bau District. The area covered by Mining Leases at the end of May was 6,780 acres, and, of the 39 leases extant, two cover quicksilver and the remainder gold and silver. Five Exclusive Prospecting Licences for gold and silver, each issued for a term of one year, and covering in all 1,195 acres, were in existence on May 31, 1940.

Fifty-four tons of antimony ore were exported during the above-mentioned period.

ABSTRACTS AND NOTES

Obituary—Sir Robert Hadfield.—It is with very deep regret that we have to record the death on September 30, 1940, of Sir Robert Hadfield, Bart., D.Sc., D.Met., F.R.S.

Sir Robert Hadfield had a long association with the Imperial Institute both as a member of the Mineral Resources Committee from its inception until 1926 and then as a member of the Advisory

Council on Minerals. His generous donation of £1,000 in 1936 for the purpose of carrying on the publication of monographs on mineral resources came at a time when the Imperial Institute was desperately short of funds, and when this branch of the work in particular was in serious jeopardy of extinction.

Hadfield was a brilliant pioneer in the field of metallurgical research and will always be remembered in particular for the part he played in the development of manganese steel, silicon steel, and other alloy steels. In addition to numerous scientific and technical papers, he published three books, namely, *Metallurgy and its Influence on Modern Progress*, *Faraday and his Metallurgical Researches with special reference to their bearing on the Development of Alloy Steels*, and *Empire Development and Proposals for the Establishment of an Empire Development Board.*

Through the course of a long and active career, Sir Robert, who was born in Sheffield in 1858, was honoured by many countries. He was knighted in 1908, elected a Fellow of the Royal Society in the following year, and created a baronet in 1917. France made him a Commander of the Legion of Honour, Japan honoured him with the Order of the Sacred Treasure, and Italy elected him Commendatore of the Order of the Crown of Italy. He received numerous medals and awards, notably the John Fritz Gold Medal from the United States, the Bessemer Gold Medal of the Iron and Steel Institute, the Howard Quinquennial Prize and Premium, and the George Stephenson and Telford Gold Medals and Premiums of the Institution of Civil Engineers, four medals from France and many other honours.

Sir Robert's generosity was further shown by the Hospital which he and Lady Hadfield equipped and maintained at Wimereux, near Boulogne, during the war of 1914-1918. His loss will be deeply felt by all those bodies to which at one time or another he gave the benefit of his advice and guidance, and not least by the Imperial Institute.

Chrome Ore and Chromium.—A new edition of the Imperial Institute monograph on *Chrome Ore and Chromium* which has been entirely rewritten by Robert Allen, M.A., B.Sc., and G. E. Howling, B.Sc., of the Mineral Resources Department, was published on November 30th. (Royal 8vo, boards, 118 pp., price 2*s.* 6*d.*)

The object of this series of monographs is to present in a concise form all the available information on the occurrence, production, marketing and utilisation of specific minerals and metals and their more important products, special emphasis being laid on Empire resources.

Chromium is a metal of extreme importance in peace time and of vital importance in war on account of its employment in a very wide range of steels, non-ferrous alloys, refractories, and in numerous chemical industries such as tanning, dyeing, pigments and chromium plating.

It is mainly employed for metallurgical purposes and especially in the modern stainless steels which now have so many applications not only in the manufacture of familar domestic hollow-ware articles, cutlery, and architectural fittings, but also, and to a much larger extent, in situations where light-weight structures of great strength are required, as for instance in aircraft, superstructures of ships, and high-speed trains, as well as in innumerable items of plant for various chemical and food industries. It is probably true to say that no other metal or alloy covers such a wide field of applications.

There are also the very important heat-resisting nickel-chrome steels which grade into the nickel-chromium resistance alloys so widely used as wire or strip for electrical heater elements, and many non-ferrous alloys of which stellite, so essential for machine-tools, is an outstanding example.

Scarcely less important from the point of view of tonnage consumed are the refractories based on chrome ore. Modern methods of steel production call for improved refractory linings for furnaces and these are being met to an increasing extent by the use not only of chrome bricks but more especially by composite refractories such as chrome-magnesite bricks which possess greater refractoriness under load and improved resistance to spalling.

Lesser amounts of chrome ore are employed in making dichromates, chromic acid and the various chromium salts required in many chemical industries. Tanning probably consumes the bulk of such salts as most light leathers are now tanned in this way. Although chromium plating is now extensively employed on account of its decorative, anti-tarnish and wear-resisting properties, the amount of ore consumed for this purpose is relatively small.

All these uses are dealt with in this monograph which also discusses the mining and dressing of the ore, marketing and prices and the world's production. The main bulk of the book, however, is devoted to the occurrence of chrome ore both in the British Empire and foreign countries, no less than 43 different countries being dealt with.

The Empire is very strongly situated in regard to supplies of this strategic mineral, for Southern Rhodesia and the Union of South Africa are among the world's leading producers. India, too, possesses important deposits of chrome ore of good metallurgical grade, and Cyprus and Sierra Leone also contribute to the total output. In fact, just prior to the present war, about one-third of the world's output came from British countries and two-thirds was produced by companies under British control.

The monograph contains a large number of statistical tables of production and trade, and concludes with a selected list of references for more detailed reading.

It is hoped that everyone interested in the production and use

of chrome ore, as well as economists, teachers and the general reader will find much in this book to interest and guide them.

India's Mineral Resources and the War.—The most important war minerals produced in India are coal, manganese ore, mica, iron ore, copper ore, chromite and bauxite. Discussing these commodities in a paper recently published in *The Asiatic Review* (October 1940, pp. 733-744), Sir Lewis Leigh Fermor emphasises the point that India can make a substantial contribution to the Allies' war effort in respect to all the above minerals except copper. In the case of copper, India could still make an important contribution by undertaking the smelting of imported blister copper. Apart from the manufacture of pig-iron and steel in the country, India could easily export large quantities of high-grade iron ore should the need arise, whilst the exports of pig-iron to Britain could be enhanced. Deficiencies in bauxite supplies abroad could also be remedied.

In order to estimate the extent to which the mineral industries of India have expanded since the last war and with a view to determining India's ability to help in the present war, Sir Lewis compares in the first instance the quinquennial averages of mineral production for 1934-1938 with those for 1914-1918, here reproduced in Tables 1 and 2 on pp. 482 and 483. These show that the total average annual value of the war minerals has increased from £9,677,647 in 1914-1918 to £12,807,611 in 1934-1938, whilst the total value of all minerals has increased from £9,860,185 to £13,609,844 in the same periods. Comparing the production of the two periods, mineral by mineral, and now noting quantities instead of values, it is seen that, with the exception of gold, saltpetre, tungsten ore, and corundum, increases, often of considerable extent, are shown by every mineral. Specially noteworthy are the increases in the output of petroleum from an annual average of 7·3 million gal. to an average of 74 million gal., owing to the development of the Digboi field in Assam and to the success recently achieved in the Punjab; mica, from some 50,000 cwt. to some 177,000 cwt.; copper ore from 8,000 to 339,000 tons, due to the operations of the Indian Copper Corporation in Singhbhum; and iron ore from some 400,000 to nearly 2½ million tons, mainly to meet the requirements of the Tata Iron and Steel Company and the Indian Iron and Steel Company for the production of pig-iron and steel. Moreover, there have been substantial increases in the output of ilmenite, chromite, refractory materials, magnesite and bauxite, India now being the world's largest producer of the first-named mineral. The considerable increase in the production of coal from 18 to 24 million tons, though less than had been predicted in some quarters, is yet substantial, and is part of a secular process due to expanding industry, the most important factor being the iron and steel industry, with its great consumption of coke manufactured from coal.

TABLE 1.—QUANTITY OF THE MINERAL PRODUCTION OF INDIA, 1934 TO 1938 (EXCLUDING BURMA)

		1934.	1935.	1936.	1937.	1938.	Mean 1934-1938.	Mean 1914-1918.
War minerals—		*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*	*Long tons.*
Coal	*tons*	22,057,447	23,016,695	22,610,821	25,036,386	28,342,906	24,212,851	17,951,583
Manganese-ore	„	406,306	641,483	813,442	1,051,594	967,929	776,151	577,457
Gold	*oz.*	321,253	326,170	331,946	330,744	321,138	326,250	584,556
Petroleum	*gal.*	67,265,210	71,323,362	69,241,504	75,657,857	87,082,371	74,114,061	7,325,376
Mica (*a*)	*cwt.*	92,918	141,814	177,664	297,343	175,109	176,970	49,586
Salt	*tons*	1,591,311	1,568,420	1,348,222	1,493,021	1,539,663	1,508,127	1,356,043
Iron-ore	„	1,916,918	2,341,212	2,526,931	2,870,832	2,743,675	2,479,914	408,643
Copper-ore	„	328,676	350,801	357,194	371,458	288,127	339,251	8,054
Ilmenite	„	75,644	127,051	140,477	181,047	252,220	155,288	—
Saltpetre	„	8,314	8,663	8,140	8,357	7,441	8,183	20,949
Refractory materials (kyanite, etc.)	„	21,548	43,724	41,298	45,158	48,743	40,094	—
Chromite	„	21,576	39,127	49,486	62,307	44,149	43,329	22,929
Magnesite	„	14,975	16,984	15,468	26,166	25,611	19,841	10,165
Zircon	„	380	6,654	2,210	1,329	1,450	2,405	—
Bauxite	„	18	7,635	3,644	15,180	14,768	8,249	939
Tungsten-ore	„	—	—	—	18	10	4·6	28·5
Beryl	„	55	139	98	27	17	67	—
Corundum	„	—	28	1½	—	2½	6·4	24,534
Tantalite	*cwt.*	—	—	18	11	—	5·8	—
Non-war materials—								
Building materials	*tons*	7,334,797	7,461,090	6,502,971	7,240,449	8,716,434	7,451,148	1,661,699

(*a*) *Exports.*

TABLE 2.—VALUE OF THE MINERAL PRODUCTION OF INDIA, 1934 TO 1938 (EXCLUDING BURMA).

	1934	1935	1936	1937	1938	Mean 1934–1938	Mean 1914–1918
War minerals—	£	£	£	£	£	£	£
Coal	4,741,425	4,903,833	4,699,128	5,872,364	7,942,077	5,631,763	4,419,174
Manganese-ore (*a*)	388,240	768,600	1,124,422	3,229,554	2,932,445	1,688,658	1,255,330
Gold	2,196,080	2,277,159	2,293,113	2,285,404	2,274,283	2,265,208	2,250,787
Petroleum (*b*)	884,537	936,198	915,188	1,030,591	1,234,563	1,000,215	28,098
Mica (*c*)	453,423	604,111	689,963	1,079,702	845,175	734,475	383,015
Salt	683,824	689,987	554,099	612,584	710,327	650,164	785,740
Iron-ore	216,246	259,999	294,125	344,840	340,073	291,057	34,108
Copper-ore	257,133	262,316	300,993	366,150	243,056	285,930	11,806
Ilmenite	39,245	58,789	62,418	84,686	115,406	72,109	—
Saltpetre	100,614	100,420	86,273	84,048	87,197	91,710	474,199
Refractory materials	13,519	30,301	29,660	53,280	55,710	36,494	—
Chromite	23,313	36,087	45,450	62,826	50,933	43,722	20,164
Magnesite	7,385	7,918	7,684	12,326	11,984	9,459	7,568
Zircon	1,030	6,967	6,335	2,935	3,040	4,061	—
Bauxite	7	1,148	548	4,649	1,906	1,652	408
Tungsten-ore	—	—	—	1,842	716	512	4,949
Beryl	124	641	465	148	119	299	—
Corundum	—	465	32	—	19	103	2,301
Tantalite	—	—	76	23	—	20	—
Total	10,006,145	10,944,958	11,109,974	15,127,952	16,849,029	12,807,611	9,677,647
Non-war minerals—							
Building materials	710,788	664,195	657,369	729,911	840,701	720,593	121,005
Other minerals	84,422	82,213	67,286	83,459	90,821	81,640	61,533
Total	795,210	746,408	724,655	813,370	931,522	802,233	182,538
Total, all minerals	10,801,355	11,691,366	11,834,629	15,941,322	17,780,551	13,609,844	9,860,185

(*a*) *Values f.o.b. Indian ports of quantities produced.* (*b*) *Value estimated.* (*c*) *Exports.*

The large decrease in the output of gold is due to the increasing difficulties of working at ever-greater depths in the Kolar Goldfield, Mysore, but is accompanied actually by a slight increase in the total sterling value of the gold won, owing to the divorce of sterling from the gold standard. The fall in the recorded output of saltpetre is partly due to a change in the method of recording production, and partly to a recession of the industry with the removal of the special war stimulus during the last war, when saltpetre was in demand for the manufacture of explosives.

Since the last war there has been an important development of a portion of the large latent water-power resources of India, partly in the form of schemes dependent on the provision of storage facilities for India's heavy rainfall in the Western Ghats, in the Tata Company's enterprises, and partly in the development by Government agency of Himalayan water-power in the Punjab. Further schemes are in course of development in the hills of Southern India. It is to be hoped that at least one of these schemes may provide electrical energy at a cost cheap enough to permit of the smelting in India of metallic aluminium from alumina extracted from Indian bauxite.

Lead in South Africa.—Deposits of lead ore in many different districts have recently been investigated by the Geological Survey of the Union of South Africa, and the following brief account of the more promising localities is taken from *Industrial Minerals, Quarterly Information Circular*, April to June 1940, issued by the Department of Mines of the Union in August 1940.

The ore-bodies occurring in the Marico District are mostly confined to the upper portion of the Dolomite Series, and are either in solid dolomite, in quartz veins in the dolomite, or in residual products of leached-out dolomite. Their presence is frequently indicated by slumped areas, manganese earth, or wad. The lead ore is galena which forms small specks and thin stringers in dolomite or vein quartz, or occurs as scattered lumps or nodules of different sizes in irregular bodies of manganiferous earth. Occasionally, as on Buffelshoek and Witkop, for example, the ore is in pipe-like bodies of altered material. Minerals such as zinc-blende (sphalerite), vanadinite, and cerussite may occur with the galena, and in the mine on Rhenosterhoek 211, sulphides such as chalcopyrite, pyrite and cinnabar have also been found. The cinnabar there, however, is of no economic significance. Small amounts of silver seem to be always present in the galena.

From time to time small tonnages of lead have been produced from the various deposits, but at present lead is being mined only on Rhenosterhoek 211. The ore reserves here are estimated by the owners to be about 100,000 tons containing about 20 per cent. lead minerals. The dumps of wad and waste taken out since the mine first started are considered to contain about 50,000 tons with a

percentage between 10 and 15 of galena and other lead minerals. At the old Doornhoek mine, a large circular opencast working about 150 yds. in diameter and from which close on 3,000 tons averaging between 70 and 80 per cent. of lead were taken, there is a dump of about 100,000 tons which is considered to carry a fair amount of lead. More galena will probably be found in the extension of the wad body in this mine. In another prospect, on Bokkraal, about 1,500 tons of ore have recently been taken out. Here the presence of isolated patches of ore over an appreciable area seems to warrant systematic prospecting.

The fact that the distribution of lead ore in the Marico district is irregular and sporadic, and that many of the old mines have fallen in, make it difficult to estimate the ore reserves. Past mining has not removed all ore of economic importance, and there are some promising localities where new deposits or extensions of those already worked may be disclosed by proper prospecting in which geophysical methods might also be of some assistance.

In the Springs District the old Pretoria lead-silver mine on Dwarsfontein 21 was recently de-watered, thus enabling the ore-body to be examined underground. The reef, a typical galena-siderite vein, is in dominantly basic rocks associated with the Bushveld igneous complex. It is a replacement lode along a rather irregular fissure. In 200 ft. of underground exposures the reef varies in width from 7 in. to 7 ft. 9 in., in dip from 25° to 80° to the south-west. Microscopically the reef is composed dominantly of siderite with lesser amounts of quartz, galena, chalcopyrite, sphalerite and pyrite. It is usually banded longitudinally due to alterations of galena-rich, siderite-rich and, less commonly, sphalerite-rich layers. Galena seems to be practically confined to a central rich zone in the reef, where there may be many parallel thin irregular galena veins locally swelling into small stout lenses. In the north-west drive there are central longitudinal bands of nearly pure galena 6 ft. and 12 ft. in length and 1 in. wide for the greater part of these lengths. Galena and siderite occur both as coarse and minutely crystalline material. The drives were sampled systematically at 20 ft. intervals, but the results of analysis are not yet available.

A geophysical survey by means of a torsion balance is in progress to locate if possible new lodes or extensions of those that have already been worked.

At the old Ballock lead mine in the Hay District (Griqualand West), galena is present in a series of more or less parallel quartz veins in banded ironstones. The ore is scattered in lenses and irregular patches in the veins. Mining operations were abandoned after nearly 700 tons of galena had been removed. In spite of present poor showings of galena it is thought possible that the mine may yet yield a considerable quantity of galena.

In South-West Africa a lead-copper deposit in a mineralised zone of altered limestone in the Marble Series of the Damara System

was formerly opened up on the farm Hohewarte 76, about 25 miles east of Windhoek. Owing to their present state the shafts of the abandoned workings are inaccessible. The information obtained is thus based on what could be seen in outcrops, shallow trenches, and material dumped alongside the shafts, and is contained in previous reports.

Along its strike the mineralised zone can be traced for 1,800 ft. beyond which it becomes covered by overburden. Farther along the line of strike, about 7,000 ft. from the main workings, the same mineralised limestone carrying good galena reappears. The zone is not less than 200 ft. thick and dips steeply to the north-west. Underground the mineralisation is apparently in the form of grains, patches and blobs irregularly disseminated throughout the limestone. Over 300 ft. of underground development which has been done just above the water-table (which is at 70 ft. in one shaft), 150 samples were taken which gave an average of 0·9 per cent. Cu, 4·7 per cent. Pb and approximately 30 dwt. of silver. As far as could be made out from surface indications, however, the mineralisation is much poorer close to the surface. Most of it seems to be concentrated along very narrow bands spaced far apart, which would necessitate the removal of much waste rock. Comparing surface indications with the results obtained underground the greater and more widespread mineralisation in the cross-cuts might possibly be due to secondary enrichment at the water-table level, in which case values at greater depths will again decrease. If this is not so, and the values are representative, then apparently there exists here a large, comparatively low-grade proposition. The prospecting that has been done has only tested a relatively small portion of the mineralised area.

During the second quarter of 1940, 71 tons of galena were produced. The average Pb content was 56·34 per cent.

Mercury in South Africa.—With the exception of occasional small consignments from Mexico, practically the whole of South Africa's requirements of mercury for use in the amalgamation process and in the manufacture of explosives, pigments, scientific instruments, and in medicine were formerly obtained from the Spanish and Italian mercury deposits, a total of 69,648 lb. being imported in 1937, 46,610 lb. in 1938, and 80,386 lb. in 1939.

Prospectors and other interested parties have, therefore, always been particularly alert for indications of the existence in South Africa of cinnabar, the common sulphide of mercury. According to the *Mineral Resources of South Africa* (Third Edition, Union of South Africa Department of Mines, 1940), however, out of a considerable number of alleged occurrences, which have been reported by native headmen, witch doctors, and others from time to time, none, upon more detailed and scientific investigation, have ever been substantiated. These alleged occurrences almost invariably

turn out to be either fused and recrystallised imported cinnabar or else there has been confusion with minium, the red oxide of lead, or even the earthy varieties of haematite, whilst the existence of native mercury, as may well be expected, has originated from the adventitious salting of alluvials by globules of mercury from old amalgamation operations.

According to the Geological Survey, the principal authenticated occurrences of cinnabar in South Africa are those in the Lomati valley, about 25 miles from Hectorspruit on the Delagoa Bay railway in the Barberton district of the Eastern Transvaal, on the farms Bynestpoort No. 520 and Kameelfontein No. 106 in the Pretoria district, and at Monarch Kop in the Letaba district on the Murchison range, east of Leydsdorp.

The Hectorspruit deposit occurs in gritty felspathic quartzite and, except for high-grade float on the farm Singerton, the mineral is found in shear zones as streaks, clusters, or lenses with a sericitic crushed quartzite gangue, though some cinnabar has been found in quartz stringers in the quartzite. Payable deposits of this mercury ore have not yet been proved, however, though it is believed that more promising deposits in the shear zones may await discovery.

In the second group of deposits, those on the farms Bynestpoort and Kameelfontein, immediately west of the Premier mine, cinnabar occurs as small specks and patches up to a centimetre in diameter in and adjoining a brecciated zone in Magaliesberg quartzites. Another mode of occurrence is as a fine dust-like covering on quartz crystals in cracks and druses.

The Monarch Kop deposit, which was discovered in 1936, is at least several hundred feet in length and from 15 to 20 ft. in width. Here the cinnabar occurs with lenticles of quartz and carbonate in chlorite-carbonate schists. [N.B.—These deposits are now being worked, and the output of mercury, though small, is steadily increasing.]

Manganese in South Africa.—The Geological Survey of the Union of South Africa have recently re-examined most of the known manganese occurrences in the Union, other than those which are actively producing near Postmasburg, and a brief report on them is given in *Industrial Minerals, Quarterly Information Circular*, April to June 1940, issued by the Mines Department of the Union.

A borehole sunk on Aucampsrust near Postmasburg has shown that ore is still available at a depth of 60 ft. below the present surface of the ground, which appears to increase the potentialities of the Postmasburg fields as a whole. A paper on the geology of the Postmasburg deposits by L. G. Boardman is to be published in the *Transactions of the Geological Society of South Africa*.

At Caledon in south-western Cape Province a deposit of manganese ore occurs as a low hill at the Sanatorium. The hill is composed of limonitic and cherty ore with wad-like intercalations,

and is estimated to contain at least 300,000 long tons of easily attainable ore with an approximate content of 40 per cent. Mn, 15 per cent. Fe, and 5 per cent. SiO_2. The mineral springs utilised by the Sanatorium rise through the ore deposit.

Manganese ore occurs at many places in gash veins and disturbed zones in the areas formed of Table Mountain sandstone between the Cape Peninsula environs and the Cedarberg mountains. In every case the available quantity is very small, and the ore is phosphatic. No deposit of economic importance was encountered among the many examined.

There is a small production of ore at Black Rock, Kuruman Division, about 100 miles north of Postmasburg and 88 miles from railhead at Lohathla, near the junction of the Gamagara and Kuruman river valleys. An isolated outcrop of lower Griquatown banded ironstones, which dip to the west at angles varying from 25° to 47°, rises out of Kalahari sand. The hill measures 520 yds. by 200 yds. Layers of manganese ore, ranging in thickness from less than 6 ft. to 25 ft., are intercalated with the banded ironstones in slightly transgressive fashion and form low cliffs facing eastwards. Outcrop specimens have given analyses of about 53 per cent. Mn and 6 per cent. Fe. The reserves run into several hundreds of thousands of tons, and further similar deposits may be available beneath the sand in banded ironstones to the north and south from Black Rock.

In several localities in the Krugersdorp District there are shallow alluvial and eluvial deposits of low-grade manganese ore associated with past and present drainage lines. The deposits cover wide areas in the soil which overlies the dolomite. The ore consists of scattered pebbles and lumps in the soil and can only be recovered by systematic stripping of the soil. The ore is mainly a ferruginous psilomelane, and sorting to a grade of more than 40 per cent. Mn must be done by hand.

Chemical ore consisting of pyrolusite and polianite with some psilomelane is produced at Warrenslaagte. The ore occurs as scattered veinlets and incrustations in a mass of residual chert and soil resulting from weathering of the dolomite at the base of Bever's conglomerate. Laborious hand-cobbing is necessary for the production of high-grade material. The area and depth of the chert rubble ensure that production on the present scale can continue for a long time.

On Waterval 74, just west of Krugersdorp, there is a large deposit of manganese wad of good grade. It occurs in masses exceeding 40 ft. in thickness directly above the Black Reef quartzite and has resulted from the alteration of the basal beds of the Dolomite. The mass still retains the original banding of these beds and has attenuated layers of chert within it. The material is soft, varying in colour from dark sooty to mustard, and assays in bulk approximately 28 per cent. MnO_2, 21 per cent. Fe_2O_3, 9 per cent. Al_2O_3,

and 14 per cent. H_2O. The available reserves within a comparatively small area are possibly a million tons, and adjacent promising areas are so far unprospected.

An occurrence on Genaadendal in the Western Transvaal, 70 miles north of Zeerust, has been investigated. Lumps of excellent crystalline ore, said to contain 55 per cent. Mn, are found scattered in shallow soil covering dolomite in a vlei covering the contact between the Dolomite and the Pretoria beds. The reserves are probably small and transport difficult.

Geological Features of the Mawchi Tin-Tungsten Mine, Burma.— The Mawchi Mine now ranks as the largest individual tungsten producer and the second largest lode-tin mine in the world. An account of the geology of this deposit by G. V. Hobson (*Trans. Min. Geol. Metall. Inst. India*, 1940, **36**, Pt. 1, 37-78) is therefore of great interest.

Mawchi is situated in the Bawlake State, which is one of the Karreni States lying on the eastern border of Burma. The mine itself is situated in lat. 18° 49′ 30″ N., long. 90° 9′ 30″ E., 11 miles west of the great Salween river and approximately 160 miles from Rangoon. It thus lies in the Shan plateau which has an elevation of between 3,000 and 4,000 ft. above the Irrawaddy valley. The Mawchi area shows a closely packed series of sharp hills with deeply dissected valleys, and ranges in elevation from 750 ft. above sea-level on the Salween river to 8,607 ft. above sea-level at Nattaung about 18 miles away. The mine camp is situated about 3,600 ft. above sea-level, with the workings partly above but mainly below this elevation, and the mill, power stations and machine shops lie on the bank of the Kemapyu chaung some 2,000 ft. below.

The geology of the Mawchi area is comparatively simple. A series of fine sedimentary rocks consisting of clay-slates, very fine sandstones and grits, calcareous mudstones and limestone has been invaded by a biotite granite. The granite has caused a low degree of thermal metamorphism within a narrow aureole in which marble, quartzites, indurated slates and spotted grits are found. A phase of this granite intrusion gave rise to tourmalinisation and the tin-tungsten mineralisation of the Mawchi ore-body. The intruded rocks are members of a very widespread series of clastic sediments, termed the Mawchi series, which grade to the west into a highly metamorphosed series of gneisses, epidiorites, hornblende and mica schists which occur along the western margin of the Shan plateau. Their age is not certain, but they are considered to be pre-Cambrian or possibly older Palaeozoic. To the east of the Mawchi series, and exhibiting a great unconformable overlap on it, is the Plateau limestone, which here is mainly, if not entirely, of upper Permo-Carboniferous age. The granite may be of late Permian or possibly middle Jurassic age.

Compression by east-west forces gave the Mawchi series an

almost vertical dip and north-north-west strike. Into them, along the western contact of one of the limestone bands was intruded the granite, eating its way into the sediments on each side and forming an elongated dome with the longer axis parallel to the regional strike. The apex of this dome is in the central part of the mine workings. A well-marked tongue of granite also rises through the limestone to the north of the main exposure and has given rise to the ore-deposition at Bulawber.

The intrusion of the granite locally changed the regional strike at the mine to west-north-west, and opened up fractures at right angles to the strike which constituted a very favourable site for ore deposition. Further, the change in strike of the limestone was accompanied by an underturn to the north so that in the central area the dip flattens out. Owing to this underturn, coupled with the manner in which the granite has eaten away the lower part of the limestone, the latter exists as a roof over most of the mine workings. The limestone, unlike the clay-slates and silt-stones and the granite itself, remained unfissured, and therefore the mineral veins pinch out as they approach the limestone. Only in one case has a vein persisted at all into the limestone, and that for a relatively short distance. This rather unusual resistance to mineralisation of a limestone is due to the fact that the Mawchi ores were formed in open fissures under conditions of rapidly decreasing pressure which did not allow time for chemical replacement of the limestone.

Thus not only did the limestone restrict the area of fissuring, but it acted as a restraining roof above the mineralisers rising through the granite, with the result that they deposited their valuable tin-tungsten contents in a large number of relatively high-grade veins in a comparatively restricted area.

Genetically the Mawchi ores are intimately related to the granite of the area. This is normally a biotite granite of medium texture, in places showing large porphyritic crystals of felspar. Some specimens contain cassiterite as an apparently original constituent. In the mine itself, however, the granite has undergone very extensive tourmalinisation and kaolinisation. The dark coloured mineralisation consists almost entirely of tourmaline, other minerals present in relatively minor amounts being muscovite or lepidolite, calcite, fluorite and pyrites. The granite may be banded or spotted with tourmaline or may be completely altered to a quartz-tourmaline aggregate. The latter may contain valuable amounts of cassiterite or wolfram, and, indeed, wherever the country rock contains an unusually high tourmaline content it may often be of payable grade even when no veins are present.

A second phase of mineralisation formed the veins by infilling of fissures by quartz carrying tourmaline, cassiterite and wolfram. There is no evidence of successive widening of the fissures or banding in the veins, and in general the disposition of the minerals in the veins is quite haphazard. As a rule the walls are perfectly clean

and sharp, and where this is not the case the veins are usually of low grade, suggesting formation during the closing stages of mineralisation.

The area within which mineralisation of economic grade occurs takes the form of a lenticular cap at the periphery of the granite. Where the granite is in contact with the limestone this cap is confined to the granite itself; where the granite is in contact with clay-slates and silt-stones the cap is partly in the sediments and partly in the granite. This lenticular capping has its maximum thickness around the apex of the granite dome, thinning out in all directions as the granite plunges to greater depths. In depth within the granite a simple system of strong fissures is developed with a roughly parallel orientation, but higher up these break up into compound fractures. Thus a single vein in depth tends to develop one or more branches higher up so that near the top a system of anastomising veins is likely to exist. Where the fracturing passes from granite to clay-slates and silt-stones these rocks are so readily fissured that an extremely complex vein system of numerous branches and fingers develops and each individual vein is relatively thin. Thus in these rocks a type of stockwork is formed in which, however, the main lines retain the same orientation as elsewhere.

In the granite, particularly towards the periphery, there is a tendency for the tension fissures to take the form of a number of overlapping and closely offset fractures, so that instead of a single continuous vein there is a series of veins *en echelon*. So far as observed at present the offsetting is always to the west as one proceeds north.

Regarding the relationship between the tin and tungsten in the veins, careful investigation has shown that, in any one representative vein, as one descends, the ratio of tungsten to tin at first rises somewhat and then falls, at first very rapidly and then more slowly, with a suggestion that, at the economic limit of ore in depth, the ratio of tungsten to tin is again rising. In the Bulawber workings, where the veins are entirely in sedimentary rocks, the ratio of tin to tungsten is higher than the average.

In certain respects the ore deposits at Mawchi differ appreciably from the occurrences in the Tavoy and Yamethin districts to the south and north respectively. All these areas, together with the Mergui, Amherst, Thaton, Salween and Toungoo districts form a single metallogenic province, consisting of a series of sandstones and argillites, sometimes with bands of limestone, invaded by granite. Although Mawchi lies midway between Yamethin and Tavoy, and the latter have a majority of characteristics in common, Mawchi shows certain features in marked distinction from both. The Yamethin veins carry practically no accessory minerals and thus, where the veins are devoid of cassiterite and wolfram, they look completely barren. Tourmaline, so common in the Mawchi veins is absent in Yamethin and Tavoy. On the other hand tourmaline pegmatites are well developed in places in Yamethin and

Tavoy but contain no cassiterite or wolfram and are of later age than the metalliferous veins. Another difference is in the development of greisen. In both Yamethin and Tavoy the veins generally occur in greisen, whereas at Mawchi only thin runs of greisen can be found and these are unusual. It thus appears that while mineralisation at Mawchi is characterised more by boron emanations than by fluorine, though both were active, at Yamethin and Tavoy fluorine was active while boron emanations were completely absent until a stage later than the ore veins themselves. Probably mineralisation at Mawchi occurred at lower temperatures and pressures than at Yamethin and Tavoy.

Turner Valley Oilfield Developments.—Further light has been thrown on the progress being made in the Turner Valley field, Canada, in a recent article by V. Taylor, Petroleum Engineer to the Royalite Co., Ltd. (*World Petroleum*, 1940, **2**, No. 7, pp. 68-71).

Since completion of the Royalties well in June 1936 with an initial yield of 850 bls. of 44° A.P.I. crude and 2 million cu. ft. of gas per day, which demonstrated the existence of crude oil along the west flank of the faulted anticlinal structure, an active drilling campaign has been carried on along this flank.

The north and south limits of the field have as yet not been precisely demarcated, but total length to date is nearly 18 miles. During 1939 the position of the oil-water contact was definitely placed by the Royal Canadian No. 3 well, which drilled to a depth of 8,667 ft. or 4,377 ft. below sea-level. The producing zone was encountered at 8,550 ft. to 8,660 ft., and the well had an initial production of 2,000 bls. a day without water. Within two months, however, the well started producing salt water in appreciable quantities. Thus the position of edge water in this area is at approximately 4,360 ft. below sea-level.

The top of the producing zone in the shallowest gas well on the structure has an elevation of 455 ft. above sea-level, thus giving a vertical range of production of 4,840 ft., of which 2,500 ft. represents the gas cap.

The present area of the gas cap is 8,100 acres, while the potential oil area along the west flank is about 14,250 acres. The proven crude acreage up to the present totals 8,665 acres; 7,265 acres at the south end of the field and 1,400 acres at the north end. The intervening area has not been definitely proven.

Stratigraphically the field is fairly uniform and the presence of persistent markers, easily identifiable from cuttings, renders much coring unnecessary, and there is no need to resort to micropalæontology. The gas cap wells start in the Alberta Shales (Upper Cretaceous), while most of the crude wells start in the Belly River Series lying immediately above the Shales. The producing limestone has two principal zones, an Upper Porous Zone of almost pure dolomite ranging in thickness from 75 to 100 ft. and separated by

about 75 ft. of cherty limestone from the Lower Porous Zone, which varies from 20 to 120 ft. In the centre of the field this Lower Zone shows practically no porosity.

Drilling conditions in the field are complicated by structural difficulties which render fast rates of advance impossible if holes are to be maintained within the 4° deviation from vertical allowed by the Government Conservation Board. An average drilling schedule appears to be an 11 to 12¼ in. hole reamed to 16¼ to 16½ in. and set with 13⅜ in. casing, down to 1,000 ft., this requiring approximately 15 bits. A 9 in. hole is then drilled to the top of the producing limestone usually encountered between 7,000 and 8,000 ft., for which depth in 1939 the average number of bits employed was 178, and the average drilling speed 2¾ ft. per hour. This second stage is set with 7 in. casing, a task normally taking 600 bags of cement. Finally the producing zones are drilled through with 6⅛ in. bits, an operation for which 22 wells drilled in 1939 employed 41 bits each, the average footage per bit being 12½ ft. and the drilling speed 2 ft. per hour.

COST OF DRILLING BITS PER WELL

Size of Bit.	No. of Bits.	Total Cost.
11 in.	13	$1,860
9 in.	178	$17,038
6⅛ in.	41	$2,952
	Total	$21,850

The present best time for completion, held by the Royalite Oil Company, is 110 days for a well drilled to a depth of 7,415 ft., or an average of 67·4 ft. per day.

Since the formations encountered do not make good drilling mud, the addition of local clays or commercial bentonites is necessary, a mixture of the two for strata above the limestone, and bentonite alone for the limestone itself. Weighting materials (e.g. barytes) have been tried in the muds, but are not essential because high pressure gas sands are not encountered above the producing horizon. In the Porous Zones the hydrostatic head of the mud column is sufficient to overcome the reservoir pressure.

In 1939, 35 wells were completed in Turner Valley with initial productions ranging from a few barrels per day to 1,000 bls. per day. At present the total number of crude wells is 108 and there are 103 gas cap wells. All crude wells are acidised at least once, and most are given two or three treatments. The total amount of acid employed varies with individual wells but ranges from 4,500 galls. to 35,000 galls. per well.

RESULTS OF ANNUAL DRILLING PROGRAMMES

Year.	Total Footage (*feet*).	Crude Oil Wells Completed.	Total Crude Production (*barrels*).
1936 . .	52,470	3	319,845
1937 . .	245,531	27	1,916,110
1938 . .	303,112	39	6,029,010
1939 . .	281,274	35	7,180,161

The total cost of drilling and equipping a well for production in the Valley varies from $175,000 to $200,000. Under the present regulations all wells are limited to 40 acre spacing on the assumption that this should adequately drain the various plots.

Magnesia from Brucite.—A note on the occurrence of brucite in Canada appeared in this BULLETIN, 1940, **38**, 102-105. Further information is provided in an article by M. F. Goudge in *Trans. Canad. Inst. Min. Metall.*, **43**, 1940, 431-505, from which the following account of experiments on the extraction of magnesia from brucite is taken.

Of the various methods explored in the laboratories of the Canadian Bureau of Mines, calcination is at present the only one that has been found to be satisfactory. The process consists of three parts, calcination, hydration, and separation of brucite from lime. The principal product is granular magnesia, while hydrated lime is obtained as a by-product. By calcination not only is the limestone converted to lime, but the serpentine gangue also breaks down and disintegrates during the subsequent hydration.

Calcination is carried out in a rotary kiln which facilitates the necessary temperature control. Under-burning causes contamination of the final product by unburnt lime, and over-burning causes the lime to slake very slowly so that unslaked lumps are carried over into the final product. In the latter case, too, the product has a high silica content because the serpentine gangue will not readily disintegrate. Brucitic limestone calcines more readily than ordinary limestone, as brucite gives up its water of crystallisation in the early stages, and the vapour makes the rock porous, thus allowing carbon-dioxide to escape more freely. If dolomite is present in the matrix a somewhat lower temperature is needed than with a calcitic matrix.

Hydration is carried out in any type of hydrator such as is used in the lime industry, preferably one of the continuous type.

Brucitic lime is quick-slaking and for this reason the calcined rock is crushed to less than ¾ in.

Separation of brucite and hydrated lime is carried out in an air separator, the lime being removed, and the brucite granules are afterwards washed free of adhering lime dust. The hydrated lime is ready for shipment or storage.

In the tests the hydration product was passed through a 6-mesh vibrating screen, before entering the air separator, to remove any core or large lumps of serpentine. Some lumps of unslaked lime were also removed.

Washing of the granules is carried out by mechanical agitation, preferably in warm water, time being allowed for slaking of any quick-lime still present. The wash-water may be used in the hydration process. From the washing unit the granules are discharged to vibrating screens in series to separate the serpentine. The screens are equipped with water sprays to complete the washing.

The final product is in rounded granules ranging in size from 8 to 35 mesh. The chief impurities, calcined serpentine and lime, are also in the form of rounded granules much smaller in size than the magnesia, hence they tend to be present in greater proportion in the finer fractions and a very pure product can therefore be obtained if only the coarser fractions are saved.

EXTRACTION TEST ON BRUCITIC LIMESTONE FROM RUTHERGLEN

Analysis of Rock used in Test

SiO_2.	Fe_2O_3.	Al_2O_3.	MnO.	CaO.	MgO.	CO_2.	H_2O+105°C.
0·43	0·52	0·21	0·15	23·28	32·40	33·84	8·70

Analyses of Calcined Brucite Granules of Various Sizes

Screen Mesh.	Per cent.	SiO_2.	Fe_2O_3.	Al_2O_3.	MnO.	CaO.	MgO.	H_2O + 105°C.
+20 .	60·53	0·38	1·68	0·29	0·20	0·90	94·42	2·37
−20+28	9·65	0·90	1·68	0·64	0·23	1·77	93·27	1·82
−28+65	15·79	3·00	1·53	1·03	0·26	4·23	87·18	2·74
−65 .	14·03	0·80	0·66	0·40	0·26	14·98	70·58	9·63

Cumulative Analysis of Calcined Brucite Recovered

+20 .	60·53	0·38	1·68	0·29	0·20	0·90	94·42	2·37
+28 .	70·18	0·45	1·68	0·34	0·20	1·02	94·26	2·29
+65 .	85·97	0·92	1·65	0·47	0·21	1·61	92·96	2·38
+65&−65	100·00	0·90	1·51	0·46	0·22	3·49	89·82	3·39

The calcined washed brucite is dead-burnt if it is to be used for refractories or may be dried for other purposes.

Each stage of the process has been tested on a commercial scale and it is estimated that it should be possible to produce magnesia by this method at a cost of $30 per ton.

U.S. Production of Secondary Non-Ferrous Metals during 1939.— The total value during 1939 of the secondary aluminium, antimony, copper, lead, nickel, tin, and zinc recovered as metal and in alloys and chemical products in the United States amounted to $199,856,800. Metals recovered from new scrap (materials produced

SECONDARY NON-FERROUS METALS RECOVERED IN THE UNITED STATES, 1939

Metal.	From new scrap.	From old scrap.	Total.	
	Short tons.	*Short tons.*	*Short tons.*	Value $.
Aluminium .	15,100	34,900	50,000	19,750,000
Antimony .	150	9,660	9,810	2,425,000
Copper . .	212,800	286,900	499,700	103,937,600
Lead . .	30,700	210,800	241,500	22,701,000
Nickel . .	1,910	1,010	2,920	2,044,000
Tin . . .	12,300	16,860	29,160	29,276,600
Zinc . .	144,540	45,100	189,640	19,722,600
Total value	—	—	—	199,856,800

as a result of manufacturing operations) were valued at $81,868,200 and metals recovered from old scrap (materials returned from use) were valued at $117,988,600. The following statistics of production have been compiled by the United States Bureau of Mines and have recently been published in *Mineral Market Reports, No.* 859.

German, Italian and Japanese Talc Deposits.—The following notes relating to the talc industries of Germany, Italy and Japan are taken from a monograph entitled *Talc, Steatite and Soapstone: Pyrophyllite*, by Hugh S. Spence, recently published by the Canadian Department of Mines and Resources.

Germany.—Germany produces a considerable amount of steatitic talc (7,790 metric tons in 1937), but is dependent on imports for most of her requirements of ground talc. Imports of the latter in 1936 totalled 24,144 long tons, and in 1937 15,834 tons, about half of it secured from Austria. In addition 2,557 tons of "soapstone" (steatite) was imported in 1937, most of it from Manchuria.

Most, if not all, of the German production is massive steatite ("Speckstein") obtained from deposits at Göpfersgrün and Holenbrunn, near Wünsiedel, in the Fichtelgebirge, Bavaria. The steatite occurs along the contact of granite with limestone and phyllite, and is an alteration product of a variety of minerals, including quartz, dolomite, hornblende, etc. It is used extensively for "lava" purposes. Some low-grade talc, in part of soapstone character, associated with serpentine, has also been mined at various times near Schwarzenbach a.d. Saale; Zell, in Oberfranken; and various other places in the same general region in Bavaria.

The Holenbrunn steatite is mined by Steatit Magnesia A.G., which processes the material in a local plant, where large moulded or cast insulators are also made. In addition, the company has two plants at Lauf, Bavaria, turning out dry-pressed steatite bodies as well as a variety of sawn, turned, and drilled steatite shapes.

Italy.—Italy is one of the world's leading talc producers, and in 1937 reported an output of 45,714 metric tons, with exports of nearly 16,000 tons. The United States is a heavy importer of Italian talc, taking 7,000 tons in 1937. Italian talc is of high quality, both on account of its purity and snow-white colour, and is one of the highest-priced talcs on the market, being in special demand for cosmetic uses.

Most of the Italian production comes from mines controlled by a single company, the Societa Talcoe Grafite Val Chisone, and situated at high altitudes (4,700 to 6,800 ft.) in the Cottian Alps, west of Pinerolo, in Piedmont. The same company also mines talc on the French side of the mountains. Owing to the elevation of the deposits mining is confined to the summer months. The crude talc is sent down the mountain side by aerial cable-way to storage sheds in the valley, whence it is transported by truck to a mill at Malanaggio. The deposits form irregular beds and lenses in dolomitic

limestone, dipping rather flatly into the mountain with thicknesses up to 25 ft. A single mine, the La Roussa, is credited with a production of about 10,000 metric tons per annum. Milling is performed both by Raymond mills and stone chaser-mills, in closed circuit with bolting trommels and air separators. Exhaust fans draw off an ultra-fine dust product from the chasers, elevators and bolters, this forming the finest cosmetic grade. The remainder goes mainly to the paper, rubber, and textile trades, some being used locally at Villar Perosa in the manufacture of dry-pressed electrical insulation articles. A considerable part of the output goes to world export. Five standard grades are made, ranging in price from $20 to $40 per ton f.o.b. Most of the exports to the American continent comprise the higher priced grades, the wholesale delivered price of which ranges from $45 to $80 per ton.

Lava talc (steatite) has also been produced since 1926 in Italy, the sources being at Iglesias and Orani (Nuoro), in Sardinia, where deposits are operated by the Societa Anonima Talco Enrico Tron, of Leghorn.

In 1932 Italy was credited with 21 producing talc mines, employing a total of about 500 hands.

Japan.—Japan has not appeared in the statistical record of talc-producing countries since 1927, in which year she had a reported production of 59,000 long tons. In the preceding five-year period (1922-26), annual production was given as between 35,000 and 48,000 tons, the material including " talc, steatite and agalmatolite." In 1930 credit was given for an annual production of around 40,000 tons.

Despite these statistics, there is little doubt that practically the whole of the above large tonnages should in reality be credited to Manchuria, the material being imported into Japan in the crude form for grinding, and in the ground form being subsequently reported as of Japanese origin.

According to recent advice, the rapid development of the textile, paper, cosmetic and other industries in Japan has occasioned a great increase in demand for ground talc, about 98 per cent. of the present requirements being filled by imported crude Manchurian talc ground in Japanese mills. There are stated to be ten Manchurian talc mines under Japanese operations, the output of which is handled by the Japan-Manchukuo Trading Company. The crude talc is quoted at between $5.50 and $14.50 per short ton c.i.f. Osaka, and the ground product at from $7.25 to $15.50 per ton f.o.b. mills, according to grade. Imports of talc (and soapstone) into Japan in 1936 totalled 64,674 long tons, and in 1937 were over 86,000 tons, practically all of which was of Manchurian origin. Although a proportion of the production of ground talc finds a foreign market (9,158 short tons, valued at about $117,843, in 1936), the great bulk of it goes to domestic industries, making Japan probably second only to the United States in point of talc consumption.

Most of the output goes to the textile, paper, rice-polishing and cosmetic trades, and there is probably also some consumption of cut furnace stone (block talc) for metallurgical purposes and for ovens and stoves.

Synthetic Cryolite in Italy.—In a note published in the *Chemical Trade Journal*, August 30, 1940, and quoted from the Italian press, it is stated that the present capacity of the synthetic cryolite plant of the Montecatini Company at Porto Marghera, Venice, is 1,000-1,200 tons per annum. When the extensions now under way are completed, however, the capacity will be 3,000 tons. The principal raw material used for the production of the cryolite is the fluosilicic acid scrubbed out of the waste gases of the superphosphate plants at Porto Marghera; it is obtained in the form of a solution containing 150 grammes of acid per litre. Material from other fertiliser works of the Montecatini group of companies reaches Porto Marghera in the form of sodium fluosilicate. It is considered that Italy's potential capacity for synthetic cryolite is at least 5,000 tons per annum, a quantity adequate to leave a certain margin for export.

Cryolite is a sodium aluminium fluoride of considerable importance as a flux in the production of aluminium from alumina, and in the manufacture of glass and enamels; it is also used for insecticides. The naturally-occurring mineral is mined in only one place in the world, namely, at Ivigtut, Greenland. In general, it may be said that whilst the natural and synthetic materials can and do replace each other in industry, natural cryolite is normally preferred in the aluminium industry and artificial cryolite in the enamel industry. Both Germany and Italy, however, are making full use of their synthetic material. The phosphate rock from which Italy manufactures her superphosphate and from which the by-product is obtained for the production of synthetic cryolite is largely obtained from Morocco and Tunis.

Italian Synthetic Nitrogen Plant.—The newly completed synthetic-nitrogen plant of the Montecatini Company at San Guiseppe de Cairo is of interest not only from the chemical and engineering point of view, but also in view of Italy's entry into the war, as the plant produces nitric acid and nitrogen compounds for both explosive and civil uses. A description of the plant and the processes employed appears in the *Engineer, Lond.*, **170**, 4425, 285-286.

Coal, the chief raw material other than air, is brought by a 12 mile cableway from the port of Savona at the rate of 2,200 tons daily. The coal is distilled in three batteries each of thirty-seven retorts with an individual capacity of 200 tons a day. The retorts are heated partly by by-product gas and partly by producer gas made from some of the by-product coke. The resulting gases are first purified in the usual way, then compressed and washed with

soda solution to remove carbon dioxide. By further compression and cooling to -190° C., the gas is liquefied, hydrogen alone remaining in the gaseous state. The hydrogen is removed and combined with nitrogen to form ammonia. Nitrogen is obtained by the fractional distillation of liquid air, oxygen also being obtained and used in a later stage of the process for the oxidation of ammonia. The mixture of hydrogen and nitrogen is forced into Fauser type columns at a pressure of 300 atmospheres and is catalysed to a mixture of liquid and gaseous ammonia. Production amounts to about 70 tons of ammonia per column per day.

For the oxidation process ammonia is admitted to a Fauser catalyser from a mixing chamber. The oxygen is provided by air to which the oxygen from the liquid air is added. In the catalyser the mixture is burned on platinum-rhodium wire netting at atmospheric pressure and a temperature of about 1,000° C. The reaction has about 92 per cent. efficiency, the main reaction being $4NH_3 + 5O_2 = 6H_2O + 4NO$. The remaining 8 per cent. is subject to the reaction $4NH_3 + 3O_2 = 6H_2O + 2N_2$. 270 kilos of ammonia produce 1 ton of nitric acid.

On leaving the catalyser the mixture of gases has the following approximate composition: water, 17·8 per cent.; nitric oxide, 9·8 per cent.; oxygen, 9·4 per cent.; nitrogen, 63·0 per cent. The gases pass to a heat exchanger where they lose heat to the incoming oxygenated air, which is on its way to the mixing chamber, and pass on to a steam generator which generates the steam for the operation of the compressor turbine. The gases are then cooled to about 25° C. and the water vapour is removed and run off to the absorber. The gases proceed to a turbo-compressor for compression to 7 atmospheres, the heat generated being removed by a heat exchanger. The gases pass on to the absorber where they are first washed by a spray of water from the cooler and then bubble through the resulting liquor. Nitric acid of 40 to 42° Bé. is thus obtained.

The gas leaving the absorber is at 7 atmospheres pressure and ambient temperature. It is run through the heat exchanger mentioned above to absorb the heat of the gas after compression. Thence it runs through a turbine where it is cooled and reduced to a pressure of 1·8 to 1·0 kilos per sq. cm. The energy thus produced is used to provide part of that required by the compressor, the remainder coming from the turbine operated by the steam from the generator as detailed above.

The dilute nitric acid is concentrated to 48° Bé. by means of sulphuric acid, produced by the combination of sulphur from pyrites and hydrogen over a vanadium catalyst. The dilute sulphuric acid is then used for the production of ammonium sulphate.

Glass Fibres.—A note on the manufacture and uses of mineral wool appeared in a recent number of this BULLETIN (1939, **37**, 2).

Further information, particularly on the subject of glass fibres, is contained in an article by D. Wolochow in *Can. Chem. and Proc. Ind.*, 1940, **24**, 7.

During the war of 1914-1918 the Germans produced glass wool as a substitute for asbestos, but the fibres were relatively coarse, harsh and brittle. The glass was pulled from orifices in the furnace wall by means of mechanically driven winding drums.

It was later found in the United States that the diameter of the fibre depended on the viscosity of the glass, the size of the orifice and the rate of drawing. In 1931 the winding drum was replaced by a steam blast and soon after that a precious metal alloy bushing was used for the orifices. This could be heated electrically and a free flow of glass through small orifices obtained, while the use of high pressure superheated steam made it possible to attenuate the fibres at speeds exceeding the velocity of sound. Later a small electric furnace with a row of orifices on its underside and a steam blower just beneath was used, the fibres being collected on a conveyor some way below. Optical glass first made into spheres was fed into the furnace and it was found possible to produce fibres with a uniform diameter of 0·0002 in., suitable for the manufacture of yarn and fabric, on a commercial scale. At one plant 102 filaments are pulled at one time and joined together into a strand on a spinning drum at a rate of over 6,000 ft. per minute.

The flexibility and strength of glass fibres increases approximately inversely as the square of the diameter. The tensile strength of fibres of 0·0002 in. in diameter is about 250,000 lb. per sq. in., but when combined into strands it is about 20,000 lb. per sq. in. as the adjacent fibres cut and scratch each other.

Glass yarn and tape are used in electrical insulation on account of their properties of high tensile strength, high dielectric strength and heat resistance. Glass cloth is used as a filtering medium in chemical industry. Coloured glass textiles which are readily washable can be made and open up many possibilities. Glass textiles are, however, not as resistant to heat or abrasion as are asbestos textiles.

" Red Mud " as a Substitute for Natural Iron Oxide in Gas Purification.—Many attempts have been made to find an economic outlet for the large quantities of ferruginous sludge that forms a residual product of the Bayer process for the production of alumina from bauxite. This sludge, more often known as " red mud," is normally dumped on waste heaps that form such a conspicuous and unsightly landscape near the extraction works. Only where there are steel works in the vicinity, or where no home supplies of iron ore are available, is the extraction of the iron content an economic proposition.

The " red mud " consists primarily of the ferruginous and other impurities that remain undissolved when finely-ground bauxite is

digested under suitable conditions with a solution of sodium hydroxide (caustic soda). These impurities consist largely of iron oxide, with alumina and silica; in addition to these the mud also contains appreciable quantities of water and soda. It is separated by means of filter presses, the remaining sodium aluminate solution afterwards being decomposed to aluminium hydrate, which, on calcination, yields alumina.

The possibility of utilising " red mud " as a substitute for the well-known iron oxides used in gas purification has recently been reviewed by Mr. J. M. Dow in a paper entitled " Oxide Purification—Wartime Practices and Substitutes," published in the *Gas Journal*, September 11, 1940, pp. 449-453. Early investigations have shown that the material without further treatment remains comparatively " dead " to hydrogen sulphide, despite its relative similarity to the established iron oxides used for its extraction from ordinary coal gas. This may be seen from the following table:

IRON-OXIDE GAS PURIFIERS

Sample.		% Free H_2O.	% Dry Basis.				Capacity for absorbing moist H_2S gas based on 4-hour cycles.*		
No.	Source.		SiO_2.	Al_2O_3.	Fe_2O_3.	Na_2O.	1st Cycle.	2nd Cycle.	3rd Cycle.
1	By-product (Foreign)	49·55	2·55	10·09	55·60	4·16	56·9	55·9	51·4
2	Synthetic (British)	27·92	13·36	8·58	47·31	0·67	48·2	53·8	48·8
3	Natural (Foreign)	30·25	6·35	6·55	62·70	—	47·4	55·3	50·1
4	Partially Spent	18·71	13·41	5·60	34·70	—	25·1	22·4	26·1
5†	By-product (British "red mud")	23·35	8·41	15·26	56·14	6·44	1·8	2·92	3·37

* *Calculated according to Weyman's formula, viz.*—

$$\frac{\textit{Increase in weight of sample}}{\textit{Weight of } Fe_2O_3 \textit{ in sample}} \times 100.$$

The maximum theoretical capacity is 63·75 *per cent. Each cycle consists of a fouling and revivifying process.*

† *By-product " red mud " from British aluminium industry.*

The relative inactivity of " red mud " is attributed to the presence of sodium aluminium silicate which prevents the iron oxide from absorbing hydrogen sulphide by enshrouding the particles in a wall of so-called " water glass," and hence interfering with its state of hydration. Early attempts to liberate the oxide were only partially successful. The mud, for instance, was calcined in a reducing atmosphere obtained by mixing it with coal dust or by using producer gas, but the " treated " oxide had purely a catalytic effect on the breaking up of the hydrogen sulphide. The reaction is indicated by the following equation:

$$Fe_2O_3 + H_2S + O = Fe_2O_3 + S + H_2O$$

As a commercial reagent the "treated" oxide could not compete with the "active" oxides then available, and apart from a few companies who were prepared to experiment, little was heard of it. It was felt, however, that if the protective layer could be destroyed, the liberated oxide should be capable of forming a sulphide. Acid washing was therefore resorted to, and this has met with a considerable measure of success. The following results show that the capacity of "red mud" for absorbing hydrogen sulphide increases after washing with sulphurous acid, this acid being used largely for economic reasons.

Gms. SO_2 per 100 gms. of "red mud."	1st Cycle.		2nd Cycle.	3rd Cycle.
	4 hrs.	22 hrs.	4 hrs.	4 hrs.
16·0	3·70	23·24	33·41	38·97
21·4	4·31	29·64	46·52	44·34
32·0	4·99	39·31	43·77	41·20

From the above it will be seen that further investigation is still necessary to improve the activity of the treated mud during the first cycle. The results, however, though inferior to those obtained with the imported materials hitherto commonly employed in gas purification, show a high degree of activity, and since these activated muds contain a larger percentage of iron oxide than do the imported materials, they may be expected to have some advantage in respect of longer active life than the latter. There are, nevertheless, certain difficulties in the way of their practical use and one of them has hitherto been cost. Mr. Dow concludes, however, that on a basis of 20 gms. of SO_2 per 100 gms. of dry mud, and using spent oxide containing 50 per cent. free sulphur, 95 per cent. of which should be capable of conversion into SO_2 solution, the cost of purifying gas by this method should not prove excessive. The author, in conclusion, expresses his thanks for the valuable assistance given him by the British Aluminium Co. Ltd.

Bentonite.—The uses of this peculiar clay-like substance continue to increase, and the quantity produced annually in the United States now reaches nearly 200,000 tons a year, but statistics are unsatisfactory, because, owing to the large number of clay-like materials, with varying physical properties and applications, which fall within the definition of bentonite proposed by petrologists, there is much confusion as to what should be recorded as bentonite. These include not only the typical Wyoming types which have the characteristic of swelling enormously when wetted, but also the so-called bleaching clays and even some fuller's earth. From the practical standpoint it would seem best to apply the name bentonite strictly to those members of the group which swell up and absorb large quantities of water. They occur notably in

Wyoming, California, S. Dakota, Nevada, Utah, and several other States, and are extensively worked. There are also deposits in Canada, the Union of South Africa, New Zealand, Italy, the U.S.S.R., Poland, Germany, Roumania, France, China, Japan, and Mexico, but few of these deposits have been worked. One of the largest known deposits outside the United States is that on the Isle of Ponza in Italy, where the bentonite is stated to be unusually white and free from iron.

The most detailed and informative publication on bentonite yet issued has recently appeared as *U.S. Bur. Mines, Technical Paper No.* 609, which is a revision by J. E. Couley of *Technical Paper No.* 438 by C. W. Davis and H. C. Vacher, which appeared in 1928.

The uses of bentonite are now legion, but the great bulk is consumed by foundries as a bond for the sand used in making moulds for metal castings, and as an ingredient in oil-well drilling muds.

In the foundry bentonite is preferred to other bonding clays on account of its high bonding efficiency, lower water content, high covering power, long life, high strength and refractoriness and the greater permeability it imparts to the moulds. Only about one-third as much bentonite is required to produce equivalent results as with ordinary or fireclay bonds.

In oil-well drilling bentonite performs the triple function of suspending the drill-chippings, of sealing cracks against water loss and of preventing sloughing of the walls of the hole.

The many other uses of bentonite, most of which are well-known, include its application as a filler in various products and compositions, as a detergent, as an emulsifier, in chemicals and in the refining of oils and fats, and relatively little change has taken place in the importance of these according to consumption.

Within recent years, however, a number of fresh uses for bentonite have been discovered, and in many cases patented, which either singly or together may eventually account for a considerable additional consumption. Notable among these newer uses are those in sewage and water treatment, in the clarification of food products, as a suspending agent in animal foods, in dry batteries and as a thermal insulating medium. The use of bentonite in the inhibition of corrosion in stressed steel pipes, as for example in oil-well casings, and its use in leather treatment have also been announced.

A use for bentonite which has attracted considerable attention is in the production of synthetic, thin, transparent films known as alsifilm. These films, in addition to being suitable as a packing material, have electrical properties which, it has been claimed, may give them possibilities in the field of electrical insulation.

Flotation in Cement Manufacture.—Froth flotation is now being used for correcting the chemical and physical composition of the

raw materials used in cement manufacture. This novel application of flotation differs from normal in that its purpose is to alter the proportions of alumina, lime, silica and iron oxide present in the cement mixture, whereas usually its purpose is to separate one or more ore minerals from gangue material. In an article in *Ind. Eng. Chem., Ind. Ed.*, 1940, **32**, 645-651, G. K. Engelhart reviews the latest developments in this field.

The three important sources of calcareous raw material for cement manufacture are high-grade limestones, argillaceous limestones and marls or chalks. Alumina, which occurs in the form of mica, kaolin and felspar is often in too great abundance to allow of correction of the cement mixture by the addition of other rocks, especially in the manufacture of cements with a low heat of hydration and of those resistant to sulphate and chloride solutions (i.e. sea water, acid ground water, and calcium chloride when used for ice removal on concrete roads).

It is possible by using certain reagents and by introducing them in small quantities at each stage in the flotation process to cause differential separations, so that alumina minerals can be separated from calcite and quartz. Further, mica and talc may be separated as a concentrate to be discarded, while calcite, quartz, etc., can be recovered from the tailings.

At a plant in Pennsylvania the removal of a micaceous concentrate from the argillaceous limestone used as the raw material corrects the deficiency in calcite and uncombined silica, and reduces the excess of alumina, magnesia and alkalies, though for special classes of cement it may be necessary to add further silica. The process involves grinding, classifying, flotation and thickening. The coarser fraction from the classifier is subjected to flotation to remove a calcite concentrate. The tailings are hydraulically classified to remove some of the mica, the remaining mica being removed as a concentrate in a second flotation operation. The tailings from the last operation, which are high in silica and low in alumina and magnesia, are mixed with the original calcite concentrate before passing to the thickener. The fines from the original classification may either be added direct to the mixture before thickening or may be subjected to flotation to give a fine calcite concentrate for use in the mixture. The product passes from the thickener to kiln or storage, the mica to waste.

At Parana, in Argentina, flotation is employed to remove as tailings, coarse quartz, which is an undesirable constituent of the raw material mixture, as it will not react to form the calcium silicates necessary in cement, if its grain size is more than 325 mesh.

BOOK REVIEWS

Books for review should be addressed to ".The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

MINES REGISTER. SUCCESSOR TO THE MINES HANDBOOK AND THE COPPER HANDBOOK. Vol. XX, 1940. Pp. 942, 9 × 6. (New York : Atlas Publishing Company, 1940.) Price $25.00.

The previous issue (Vol. XIX) of this extremely valuable and comprehensive work on the non-ferrous metal mining companies in the Western Hemisphere appeared in 1937 and was noticed in this BULLETIN (1938, **36**, 450). The present volume again appears in one part, an arrangement first made possible in the 1937 edition by the use of smaller type and a more economical form of set-up. A further modification has now enabled the latest additions to be incorporated with the earlier information within 942 pages as against 1,340.

Since the appearance of the previous issue a great many changes have taken place in the non-ferrous metal mining industry in the United States, Canada, Mexico and South America. Thus, for example, owing to the war, many dormant mines have been brought into production and active mines have accelerated their output. New mining companies have been formed and in some cases important changes have taken place in their personnel. There have also been changes in production costs, earnings, financial structure, methods of mining, listing of securities and security values. All these changes have been carefully checked so that the 1940 edition presents a complete revision of the previous issue and contains the latest authentic information.

The new edition contains a description of more than 7,000 active mining companies and a list of more than 24,000 inactive mines, together representing an increase of more than 30 per cent. in comparison with the number listed in the 1937 edition. For the convenience of the reader, the new edition has been divided into four parts comprising (1) a description of active mining companies in the Western Hemisphere ; (2) a description of some of the largest mining companies located in different parts of the world ; (3) addenda in which is given information on mining companies that arrived too late for inclusion in the main body of the first text ; and (4) lists of inactive or dormant mines.

The 1940 edition of the *Mines Register* also contains a comprehensive statistical section dealing with metal production, consumption, imports, exports, price trends, etc. Whilst these statistics are

largely drawn from American sources, a number of them have been quoted from the *Statistical Summary* of the Imperial Institute.

A special section contains a list of mining engineers, mine managers, superintendents and purchasing agents, and another section contains a list of metal mining securities, giving the name of the security, the exchange on which they are quoted and the high and low prices from 1931 to 1939.

The work concludes with a comprehensive "Buyer's Guide" to the various types of mining machinery, equipment, and supplies used in mining operations, with the names and addresses of the manufacturers or distributors.

TEXTBOOK OF ORE DRESSING. By Robert H. Richards, S.B., LL.D., and Charles E. Locke, S.B. Third Edition. Pp. xiii + 608, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1940.) Price 36*s*.

Some fifteen years have elapsed since the publication of the second edition of this well-known textbook on ore dressing. Whilst a considerable amount of the former text has been retained in the present, the chapter on flotation is entirely new and somewhat expanded, mill flow-sheets show the latest practice, the section on coal dressing has been completely revised, and numerous changes have been made throughout the work which now provides a comprehensive and up-to-date account of the principles, theory and practice of ore dressing for students and mill operators.

The present work is divided into nineteen chapters, the first of which is devoted largely to general principles and definitions. Next follows a discussion in fair detail on the important subject of rock breaking, crushing and grinding, in addition to amalgamation, the whole occupying Chapters 2-7. Five chapters are devoted to sizing, classification and concentration by tables, jigs and vanners, as well as by other methods, and flotation is dealt with in a separate chapter (13) consisting of 56 pages. The next four chapters are devoted to the discussion of a wide variety of subjects, among which may be mentioned magnetic and electrostatic separation, panning, accessory apparatus such as automatic feeders and filters, mill data and flow-sheets, together with observations regarding mill location, design, construction and efficiency. Chapter 18 deals with ore examination and testing, brief mention being made here of the Haultain Superpanner. The final chapter consists of 70 pages and deals exclusively with coal dressing.

The work closes with a valuable appendix and index, the former containing data on specific gravities of minerals and common metals, mill formulæ and calculations, Kirby's values for ore in place, and McDonald's figures on weight of rock. Kirby's and McDonald's useful figures may be tabulated as follows:

Kirby's Value for Ore in Place

Material.	Weight per cu. ft. Theoretically lb.	Weight per cu. ft. Practically lb.	Cu. ft. per ton. Theoretically	Cu. ft. per ton. Practically
Galena	465	426	4·3	4·7
Pyrite	313	286	6·4	7·0
Blende	250	235	8·0	8·5
Hæmatite	303	267	6·6	7·5
Limonite	238	213	8·4	9·4
Dolomite	175	160	11·4	12·5
Limestone, andesite, syenite	168	154	11·9	13·0
Vein quartz, granite and granite rocks	168	148	11·9	13·5
Clay, quartz, porphyry, trachyte, rhyolite, etc.	163	138	12·3	14·5
Vein quartz with 15 per cent. galena	187	164	10·7	12·2
Vein quartz with 15 per cent. pyrites	180	160	11·1	12·5
Vein quartz with 10 per cent. hæmatite	175	155	11·4	12·9

Macdonald's Figures on Weight of Rock

Material.	Weight per cu. ft. In Place lb.	Weight per cu. ft. Broken lb.	Cu. ft. per ton. In Place	Cu. ft. per ton. Broken
Granite and porphyry	170	97	11·8	20·6
Gneiss	168	96	11·9	20·8
Greenstone and trap	187	107	10·7	18·7
Limestone	168	96	11·9	20·8
Slate	175	95	11·4	21·1
Quartz	165	94	12·1	21·3
Sandstone	151	86	13·2	23·3
Earth in bank	111	—	18·0	—
Earth dry and loose	—	74	—	27·0
Clay	118	—	17·0	—
Sand	80	—	25·0	—

In conclusion, this work, though essentially American in outlook, contains a mass of information that should prove of considerable value to all students of metallurgy and operators of ore-dressing plant.

Handbook on Witherite and its Industrial Uses. Issued jointly by the Holmside and South Moor Collieries, Ltd., and the Owners of Settlingstones Mines, Ltd., pp. 56, $8\frac{1}{2} \times 5\frac{1}{2}$. *Gratis.*

Witherite (natural barium carbonate) occurs in commercially important deposits only at two mines in the North of England which supply the world's output. On behalf of the owners of these mines an excellent survey of the occurrence, method of mining, and the many uses of this mineral has been prepared by E. W. Muddiman and presented in a well-illustrated and attractively-bound volume.

Its object is to give publicity to the witherite resources of this country and to draw attention to the various ways in which the mineral is employed in industry. The bulk of the work is concerned with the industrial outlets for the mineral, many of which, of course, are well known, but amongst the less prominent applications may be mentioned the manufacture of chrome bricks, to which increased

refractoriness is imparted by the addition of finely-ground witherite to the chromite.

There are two appendixes to the book, the first dealing with barium metal and its alloys, and with the preparation of the various barium chemicals not dealt with in the earlier part, e.g. the chromate, selenite, fluosilicate, stearate and platinocyanide; and the second being a table of solubilities and physical constants of barium compounds.

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EXHIBITION GALLERIES, FILM LIBRARIES AND CINEMA

NOTES

Exhibition Galleries.—The intensification of the air raids on London which has taken place since the last issue of this BULLETIN has led to a considerable falling off in the number of the general public visiting the Galleries during the restricted hours of opening. This is probably due more to the resultant difficulties and delays in transport, and to the Government's discouragement of non-essential travelling, than to the incidence of the air raids themselves, or to any waning of the renewed interest in the exhibits recorded in the last issue. But however caused, this falling off in the numbers of visitors, coupled with "black-out" problems which, in the Galleries, present almost insuperable difficulties, has forced the decision to close the Exhibition Galleries for the time being. The collections, however, remain intact, and facilities to inspect them by arrangement will be afforded to inquirers, colonial visitors and conducted parties.

The advent of spring, it is hoped, will bring more settled conditions, and thus permit members of the general public once more to take full advantage of the educational and recreational facilities which the Exhibition Galleries have to offer. Towards this end the displays continue to be improved, in so far as the present abnormal conditions will permit; a number of new exhibits have been added, and the rearrangement of the older exhibits on "story" lines is being continued.

With dioramas, models, photographs and specimens arranged in a related sequence a new story exhibit of the Indian wool and carpet industry has been assembled in the Indian Court. The industrial art of carpet weaving which was introduced to India from Persia and reached its zenith under the patronage of the Moghul Emperors was, for over a century following the decline of the Moghul Empire, in a state of decay. But the active support and practical encouragement accorded by the Government of India and by the ruling Princes, coupled with the improvement in the production of better Indian wool, have brought about a renaissance in the industry; so that at the present time India occupies a premier position among countries producing hand-woven pile carpets, and is an exporter of carpets to many parts of the world.

In order to show the inter-dependence between the carpet industry and Indian wool, most kinds of which are eminently suitable for the making of pile carpets, two small dioramas portraying respectively a sheep farm and a sheep-shearing scene have been constructed in the Imperial Institute studio by Mr. Herbert Cawood, and are housed together side by side in the upper section of a wall-case. In the lower section are displayed photographs of Indian

sheep from various parts of India and specimens of the wools they yield, kindly sent by the Imperial Council of Agricultural Research, New Delhi; also a model of Indian craftsmen at work on a carpet loom, constructed in the Imperial Institute studio by Mr. A. J. Carter. Thus the story of the Indian carpet is unfolded in four stages—the sheep farm, the shearing of sheep, various specimens of wool and the model of weavers at a carpet loom. On the wall above the show-case is displayed a finished hand-woven Indian pile carpet.

The labels attached to the two dioramas, the wool specimens and the carpet hand-loom model, read as follows:

I. A Sheep Farm in India

"This diorama shows a sheep farm in Southern India, where sheep-farming is practised on modern principles.

"The Indian flocks are of small size, and generally speaking there are no recognised pastures for them. In many parts of India the flocks are nomadic while in some they graze on the cultivated fields after the crops have been harvested, and on waste and fallow lands. At night they are usually penned on ryot's lands for manurial purposes. For this service, the shepherd receives a small fee, which in some cases represents his chief source of income.

II. Sheep Shearing in India

"In this diorama sheep are being sheared on a farm in Southern India. The sheep are usually clipped once a year either in the hot, dry part of the year, or in the cold season. In some places, however, shearing is done twice a year; this means a greater yield of wool, though of a shorter staple. A yield of 2 lb. of wool per sheep is considered good in India, the average being about 1 lb. Most grades of Indian wool, though somewhat coarse, are very suitable for carpet-making.

III. Wool Production in India

"The rearing of sheep and the production of wool in India are not ordinarily taken up as an industry by big business concerns as in Australia or South Africa, where sheep farmers maintain large flocks. The Indian industry is in the hands of nomadic herdsmen and small shepherds whose flocks vary in size from 25 to 100 on an average, while some combined flocks may run to 2,000 head.

"The chief breeds of sheep in India may be divided into two classes, the woolly and the hairy. They are maintained not only for wool and for the purpose of manuring the land, but also for the mutton and skins, the wool-yield per sheep being in consequence very small compared with that of Australia or South Africa.

"The need for the improvement of Indian wool has long since been recognised and increasing success is being achieved both in quality and output.

"Most kinds of Indian wool are eminently suitable for the making of pile carpets.

IV. Carpet Weaving in India

"Here carpet weavers are seen sitting at a hand loom. The loom consists of two heavy wooden rollers resting horizontally one above the other on two massive posts. The upper one rests at the top of the posts about 5-6 ft. above the ground; the lower occupies a trench dug below the level of the floor. The warp cords are fixed to these rollers and are stretched tight vertically by turning the rollers in opposite directions by means of rods fixed in holes at each end.

"Two or more weavers sit in front of the loom, and the weaving commences when the woof threads, the threads that run breadthwise, are woven into the warp threads, making a border and fringe about 4 in. to 6 in. deep. Then the master weaver takes a piece of wool from one of the balls hung overhead and passes it round the warp, chanting out at the same time the colour and number of stitches at each row, according to the design previously drawn by an artist. The other weavers follow suit. The thread of the woof is then put into the warp and is pressed by means of a comb to arrive at a close knit, and the whole row is trimmed by a pair of scissors. The weavers then pass on to the next row. As the weaving proceeds the finished portions of the carpet are rolled on to the lower roller in the trench, the upper and lower rollers for this purpose being worked in unison. The carpet is completed in the course of a fortnight or a month, the time taken being governed by the size, quality and design.

V. Indian Carpets

"India, in the past, especially under the patronage of the Moghul Emperors, has produced many magnificent carpets. The largest and finest collection belongs to H.H. The Maharajah of Jaipur, who has in his palaces over 200 carpets and rugs of seventeenth century make—an heirloom of incalculable value.

"Of modern Indian carpets, the largest and the most magnificent collection adorns the state rooms of the Viceroy's House in New Delhi. The most talented artists in the land were engaged for a year to prepare the designs, and it took 500 skilled weavers two years to produce them.

"The silk carpet which was prepared for H.R.H. The Prince of Wales on his visit to Amritsar in 1921 took more than a year to make.

"The active support by the Government of India and the ruling Princes has had a most encouraging influence on the industry; and at the present time Indian hand-made pile carpets are extensively exported to Great Britain, the United States of America, New Zealand and South Africa. The chief centres of this industry are Amritsar, Ahmedabad, Mirzapur, Jaipur, Allahabad, Benares, Bangalore and Warangal."

Through the good offices of the Chief Conservator of Forests, Uganda, the original photographs published in "Fifteen Uganda Timbers," in the Forest Trees and Timbers of the British Empire Series, have been received from the Director of the Imperial Forestry Institute, University of Oxford, and are being displayed with specimen planks of the timbers in the East African Court.

A long-standing desideratum for the West African Court has been a story exhibit to bring home to the visitor a realisation of the scourge which the tsetse fly is to the West African native and of the continual war which, under Government supervision, is being waged both to exterminate the pest and to control the diseases of sleeping sickness in humans and "nagana" in animals which it transmits. Thanks to the courteous assistance given by Dr. T. A. M. Nash, Entomologist in charge of Tsetse Investigations, Nigeria, and to Professor P. A. Buxton, of the Department of Entomology, London School of Tropical Medicine and Hygiene, this need has now been supplied. From his large collections of photographs and his fund of personal experience, Dr. Nash has very kindly supplied a series of photographs and descriptive notes which convey the whole story in a nutshell, whilst Professor Buxton has kindly prepared and presented mounted specimens of the three species of tsetse indigenous to Nigeria to which the notes refer. The notes are as follows:

Tsetse Flies

"Tsetse flies are a group of blood-sucking insects which is confined to Africa. In Nigeria tsetse live in densely shaded places along the banks of streams and rivers. They are the carriers of two serious diseases—sleeping sickness of man and 'nagana' of domestic animals. Both diseases are caused by closely related species of small germs called trypanosomes, which look like minute wriggling eels when seen under the microscope.

"The newly hatched tsetse fly is a harmless insect, but if it feeds on a man who already has sleeping sickness, then it will become infected with trypanosomes from his blood and will become a carrier of human sleeping sickness and a danger to other folk. Similarly, a young tsetse cannot infect cattle and other domestic animals with nagana unless it has first become infected itself by having fed on an animal which already has nagana. Unfortunately, the blood of wild animals, such as antelope and buffalo, is often full of nagana trypanosomes, so that it is very easy for tsetse to become a menace to cattle and other domestic animals. Curiously enough, the wild animals seem able to carry nagana trypanosomes without suffering any ill effects themselves.

"Tsetse flies, of which there are 20 species, can be easily distinguished from other blood-sucking flies because, when at rest, their proboscis (hollow, blood-sucking needle) sticks straight out in front and their wings fold neatly down the back, one under the

other, like a closed pair of scissors. Unlike most other flies they do not lay eggs, but the female produces a single grub which develops within her body until it is full-grown. The female then drops the grub in a shady place where it rapidly burrows into the earth and becomes a chrysalis from which a tsetse fly will hatch out in a few weeks time.

" Mounted specimens of the three species of tsetse which are of major economic importance in Nigeria are shown. They can all carry trypanosomes.

" *Glossina palpalis* is the dominant southern species, but it extends from the coast up to about 11° N., as far as Zaria.

" *Glossina tachinoides* is the dominant northern species, but it extends southwards to the boundary of the Northern and Southern Provinces.

" *Glossina morsitans* occurs sporadically in lonely places where big game still survives. This means that it is only found in thinly populated areas, so that it does not cause nearly so much sleeping sickness as the other two species. It is, however, a dangerous carrier of nagana disease of cattle."

The distribution of the tsetse fly in Nigeria is shown on a map, the legend for which is as follows :

" The red line shows the northern limit of tsetse in Nigeria. Tsetse are not found north of this line because the country becomes very arid as one approaches the Sahara desert ; but south of this line tsetse are found in the vicinity of every stream and river which supports riverine vegetation. The country between streams is fly-free. The shaded area shows the 'main' sleeping sickness epidemic belt, though the disease occurs sporadically in many other parts."

" *Where the Tsetse Lives.*—In the south of Nigeria *Glossina palpalis* is found along the margins of the rain forest, wherever rivers or settlements cut lanes through the vegetation. Fortunately the people of southern Nigeria suffer less from sleeping sickness, and the major problem is in the north where the disease is rife. In the north of Nigeria, a hot, dry country, the tsetse is confined to the narrow strips of thick vegetation which line the rivers and streams, and cannot survive in the open woodland."

The following photographs illustrate this section of the exhibit :

(1) " Typical village in southern Nigeria surrounded by heavy rain forest, the fringe of which is infested with *Glossina palpalis*."
(2) " A close-up of the impenetrable southern forest from which *Glossina palpalis* darts out to feed on the canoe traffic."
(3) " Typical northern Nigeria stream infested with *Gossinia tachinoides*. Note how sharply demarcated is the thin strip of riverine vegetation."
(4) "A ford across the same tsetse-infested stream."
(5) "A road crossing heavily infested with *Glossina palpalis*."

" *An Example of how the African Native Contracts Sleeping Sickness.*—The village watering place is a centre of domestic activity.

The women come down to fill their water pots, and both sexes wash themselves and their clothes. Tsetse flies concentrate around the spot and dart out from the surrounding shade to feed upon their prey. Should a traveller who has sleeping sickness rest during the heat of the day at such a place, he will probably be bitten and infect some of the local tsetse which attacked him ; these tsetse will later start infecting the local villagers, who in turn will infect more tsetse, which will bite more people—an epidemic will result."

The following photographs are shown :

(1) " The village watering place as a centre of domestic activity."
(2) "A native is washing himself within easy view of any tsetse fly lurking in the dense shade."
(3) " Investigation shows that there is a tsetse fly feeding on the man's back."

"*How a Tsetse Fly Feeds.*—In the first three photographs *Glossina morsitans* is shown feeding on a native's leg. At rest the proboscis sticks horizontally out in front, but when feeding the hollow needle is withdrawn from its protective sheath and is plunged vertically down into the skin.

" Tsetse can probe through a thick, woollen jersey as can be seen from two of the photographs."

The photographs here are :

(1) " The tsetse is half-fed."
(2) " The tsetse is nearly gorged. Note how his bloated body now sags down on to the native's skin."
(3) " The tsetse is fully gorged. Note the round, bloated body seen from above, and in profile on the right, the thin, hungry tsetse which has just alighted."
(4) "A hungry tsetse has just alighted on a native's elbow and is probing through his thick, woollen jersey."
(5) " The same fly is sucking blood. In order to accomodate more it is exuding droplets of fluid from its tail whilst retaining the more solid part of the blood."

"*What does a Native with Sleeping Sickness Look Like* ?—He shows terrible emaciation and swollen feet, and is also blind. He has now reached the characteristic sleeping stage when he is liable to fall into a deep coma, the duration of which will increase with the progress of the disease.

" It is common in Nigeria to find a mild lingering form of sleeping sickness, showing few obvious symptoms. Apart from headaches and lassitude the patient has little wrong with him, but he cannot do much work.

" Like the tsetse fly, sleeping sickness is peculiar to Africa, and must not be confused with sleepy sickness which occurs in this country and which is quite a different disease."

A photograph illustrating an advanced case of Sleeping Sickness is shown.

" *What can be done to Destroy the Tsetse* ?—The tsetse is forced

to live in the riverine vegetation bordering streams, because the climate is too severe in the surrounding country. If this narrow strip of thick bush or forest is cut down, the tsetse is exterminated. Hence the present policy in bad sleeping sickness areas is to make the population clear the riverine vegetation bordering their own local stream and watering place. In the last two years 124,000 people have been taught to protect themselves in this fashion, and it is hoped, year by year, to extend this 'community clearing' throughout the worst sleeping sickness areas.

" In very thinly populated areas with small, scattered hamlets it is necessary to move the population and concentrate them in country which has first been freed of tsetse. In one such scheme being undertaken at present, nearly 500 sq. miles of country have already been reclaimed from tsetse by clearing several hundred miles of stream. The people moved into this area are being given model villages, with good cement-lined walls and simple sanitation.

"After the war it is hoped to complete this scheme and to make a tsetse-free corridor 70 miles long by 10 miles in width, up and down which man and cattle can move without danger of infection. The area will be developed economically, and it is hoped to produce a healthier and more prosperous African farming community."

The following photographs are shown :

(1) " Natives cut down the riverine vegetation."
(2) " Bonfires are made over the stumps of felled bush so as to kill them."
(3) " The same crossing after it has been cleared and burnt. Note the piles of white ash."
(4) " Three months later the rains have broken ; the clearing has been invaded by grass which cannot harbour tsetse."
(5) " In northern areas 'partial' clearing is sufficient and the tall shade trees can be spared.
Note.—Cattle can now graze here with safety."

" *What can be done about Curing Sleeping Sickness* ?—Fortunately the majority of sleeping sickness cases can be cured, providing the disease is not too far advanced. The patient has to undergo eight injections over a period of 40 days. Since 1931 six teams of African microscopists have been trained, and these teams, under European supervision, have examined thousands of natives throughout huge areas of northern Nigeria and have treated all those who were found to have the disease. By the beginning of 1938 some 2,200,000 people had been examined and about 300,000 cases discovered and treated. It has been found that the main epidemic belt is in the central part of the country (see map) following the lines of communication, railways, roads and mining areas.

" In addition, sleeping sickness field dispensaries have been set up in the districts which have been surveyed so as to provide facilities for the treatment of fresh and relapsed cases. There can be no doubt that these measures have brought the disease under

control and have stopped its alarming spread; however, the trouble is that there is nothing to prevent a man getting sleeping sickness again and again if he remains in close contact with infected tsetse, and for this reason medical measures alone are not sufficient. To consolidate the position it is essential to break down the close contact between man and the tsetse."

Through the generosity of the directors of Elder Dempster Lines Ltd., a new diorama of Freetown Harbour, Sierra Leone, has been provided to replace the old one formerly on exhibition in the West African Court. Like its predecessor, which was also presented by the company, it is the work of Mr. Herbert K. Rooke, and was made in the Imperial Institute studio. It is considered by visitors from Sierra Leone to give a very faithful impression of the port as it appears to-day.

A photograph of the diorama is reproduced at plate VIII and the label attached to the cabinet reads as follows:

Freetown Harbour, Sierra Leone

"Freetown, the capital of Sierra Leone, was founded in 1792 following the establishment there in 1787 of a settlement as a home for freed slaves; hence the name Freetown. The Settlement became a Crown Colony in 1808, whilst the hinterland of Sierra Leone (26,000 sq. miles) was, in 1896, declared a Protectorate.

"Freetown is situated on the northern extremity of the Peninsula on a fine natural harbour, which affords good anchorage close to shore for the largest ships and has a large coaling station where thousands of tons of coal are handled yearly.

"The greater portion of the Peninsula is mountainous and well-wooded, the highest of the conical peaks being Picket Hill (2,912 ft.) which is visible for great distances at certain seasons of the year.

"The diorama shows Freetown as seen from the harbour. In the centre is the square-towered St. George's Cathedral, with Government House marked by a flagstaff. Nearby is the Secretariat with other public buildings dominated by a large cotton tree, a famous local landmark.

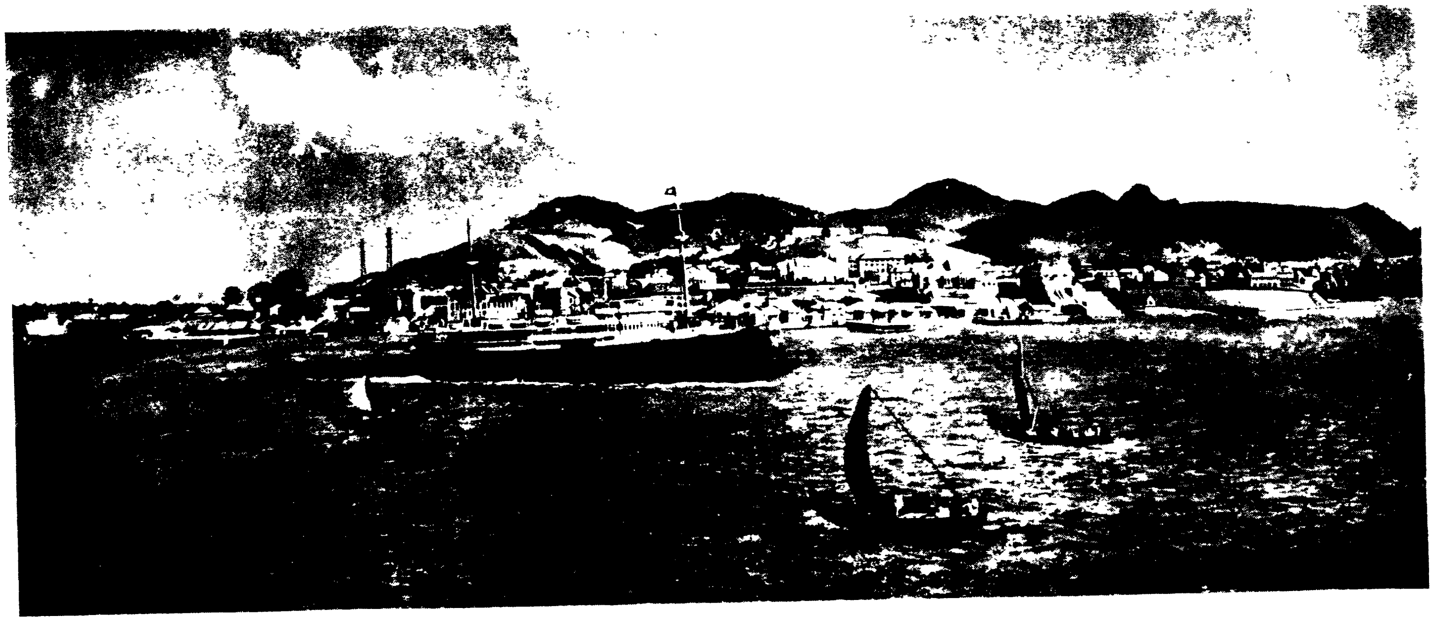
"Above the city are Tower Hill barracks, behind which is Hill Station, the residential district for Europeans.

"Amongst buildings on the water front are those belonging to important West African trading companies with the sheds of H.M. Customs in the centre, and on the extreme right the Connaught Hospital and Nurses' Quarters.

"The tonnage of shipping entered and released at Freetown in a normal year exceeds 5,000,000 tons, and in times of emergency Freetown becomes an important port of call for ships to and from India by the Cape route."

The old diorama of Freetown Harbour has, with the approval

PLATE VIII



FREETOWN HARBOUR, SIERRE LEONE.

Reproduced from a Diorama in the Exhibition Galleries of the Imperial Institute.

[*facing page 596*

of the directors of Elder Dempster Lines Ltd., been presented to the Liverpool Museum, where it is hoped it will serve a further period of usefulness.

The reorganisation of the Cyprus Court has been continued. To complete the carob exhibit a model spray showing the manner in which the pods are produced has been added. This was prepared in the Imperial Institute studio and is the work of Mr. A. J. Carter. The cabinet containing the diorama illustrating Viticulture has been painted a pleasing shade of chocolate, which not only enhances its general appearance but also throws up the diorama itself into more positive relief.

In the Australian Court new and more realistic models of cheeses and of boxed butter have been used to replace older specimens in the dairy industry exhibit. And fresh sheaves of oats and rice and an enlarged photograph of wheat harvesting have been used to renovate the food grains exhibit. These new specimens, together with a set of photographs illustrating horse-breeding in Australia, have been received from Australia House.

The exhibit of mother-of-pearl shells and other sea products of Australia has been rearranged in a more attractive form with the aid of new interior fittings in the show case. On one side of the case are displayed on a sandy floor examples of the various forms of shell utilised commercially as a source of mother-of-pearl including green snail, nautilus, trochas, and several species of pearl oyster shell; also tortoise (turtle) shell and beche de mer or trepang. Above these are exhibited photographs of scenes on the Great Barrier Reef which show a number of beautiful coral forms and the giant clam. On the opposite side of the show case are displayed photographs of pearl-fishing luggers and divers, the haul of pearl oysters, the sorting of the shell in Australia, and the working up of the shell in an English factory. Associated with these photographs are specimens of the gold- and black-lipped oyster shells in various stages of the cutting up, grinding, turning and polishing processes that are involved in the making of pearl buttons, studs, buckles, brooches, knife handles and spoons, examples of which are exhibited, and also fancy articles to illustrate the application of pearl shell as an ornamental overlay on a wood base.

In the British Malaya Court the exhibits illustrating the rubber, coconut, rice, tapioca and various forestry industries have each been converted into the popular story form, and the story of rice has been extended to show the importance of irrigation in the production of rice in Malaya.

Imperial Institute Stories of Empire Products.—The educational value of the story exhibits in the Exhibition Galleries has always been keenly appreciated by Sir Frank Stockdale, and he recently expressed a desire to obtain duplicates of many of them for use in conjunction with his new appointment as Controller of Development

and Welfare in the West Indies. Unfortunately this type of exhibit requires a degree of effort on the part of the various co-operating manufacturers in preparing special samples of intermediate stages of their manufactures, as well as photographs of processes, which could not be expected of them in these abnormal times. It was therefore suggested that a suitable alternative might be found in a pictorial display of the story, in the form of a poster chart, to be accompanied by an explanatory leaflet for the use of a demonstrator. The idea having been approved, the first of a series of the pictorial charts has been prepared. This deals with Sea Island cotton and has as caption "The Story of a Shirt." Within certain limits, the chart follows in sequence the story exhibit bearing the same title in the West Indian Court. A reproduction of this poster chart and the explanatory matter which accompanies it are given on pp. 529-532. The posters have been produced in two sizes, namely 20 in. × 30 in. and 40 in × 60 in. Copies of the leaflet, including the reproduction of the poster, are obtainable separately from the Imperial Institute, price *2d.*

Further items in the series are in preparation, and it is proposed that eventually the charts will be available for the use of lecturers, and for school and museum display purposes. The charts should prove a valuable supplement to the Imperial Institute series of Photographic Cards illustrating Empire Industries which are already issued and on sale.

Colonial Visitors.—The following is a list of officers on leave from the Colonies, etc., who have visited the Institute during the three months August, September and October 1940:

AUGUST

G. E. MANN, Principal, School of Agriculture, Malaya.
J. C. K. MARSHALL, Senior Assistant Conservator of Forests, Federated Malay States.
Dr. F. J. MARTIN, Director of Agriculture, Sierra Leone.
E. B. MARTYN, Botanist and Mycologist, Jamaica.
J. K. MAYO, Senior Botanist, Nigeria.
J. P. MEAD, Director of Forestry, Straits Settlements, and Adviser on Federated Malay States Forestry.
E. PARNELL (formerly Chief Secretary, Sarawak).

SEPTEMBER

Dr. T. A. M. NASH, Entomologist-in-Charge of Tsetse Investigations, Nigeria.
J. SHEARD, Sleeping Sickness Control Officer, Nigeria.
G. S. WILBY, Education Department, Hong Kong.

OCTOBER

F. S. COLLIER, Senior Assistant Conservator of Forests, Nigeria.
R. DUNWOODY, Senior Veterinary Officer, Nigeria.
R. A. SYKES, Senior Assistant Conservator of Forests, Nigeria.

All Dominion and Colonial Officers, as well as private residents overseas, who may be visiting London, are cordially invited to come to the Institute to see our Exhibition Galleries and to discuss scientific and technical problems in which they may be interested.

APPENDIX

IMPERIAL INSTITUTE STORIES OF EMPIRE PRODUCTS

1. SEA ISLAND COTTON: THE STORY OF A SHIRT

SEA Island Cotton, the finest, longest and most valuable of all the cottons, is a sea-loving plant which used to be grown in the United States of America and particularly in the Sea Islands off the coast of Carolina. There, however, the deadly boll weevil ruined it, and nowadays it is grown mainly in the West Indies. Owing to its special characteristics, its use was formerly restricted chiefly to the manufacture of sewing cotton, lace, fine gloves, handkerchiefs and other delicate fabrics. Of recent years a new appreciation of the varied materials which can be made from this long-stapled cotton has arisen, and, fostered by the West Indian Sea Island Cotton Association, the cultivation of Sea Island cotton has been developed.

1. *Habitat.*—At present the principal producing islands in the British West Indies, in order of the quantities produced, are Montserrat, St. Vincent, St. Kitts, Nevis, Antigua and Barbados. The finest qualities are produced in St. Vincent. The cotton plant is grown as an annual, chiefly by peasant cultivation on small holdings. The best time for planting the seed is just before the rainy season commences, and the crop is harvested during the dry weather period.

2. *Cotton Plant.*—The plant is a flowering shrub with vine-like leaves and yellow flowers in shape not unlike those of a mallow or hollyhock, which are closely related to it. As the flowers fade they are succeeded by green seed pods ("bolls") about the size of a walnut, each containing from five to eight seeds.

3. *Cotton Boll.*—When the pods are ripe they burst open, revealing a fluffy mass of white fibres in which the seeds are embedded. This is termed "seed-cotton" and is picked before it has become soiled by exposure. Thus each plant has to be picked over several times as individual bolls become ripe.

4. *Seed-Cotton.*—Each seed has attached to it its own "beard" of cotton lint. The one illustrated has been teased out to show the fibres adhering to the seed in the form of a halo. The fibres average 1¾ in. to 2 in. in length, but the finer types may even exceed 2 in.


No I
IMPERIAL INSTITUTE STORIES of EMPIRE PRODUCTS
SEA ISLAND COTTON
The Story of a Shirt
1 Cotton Plantation
2 Flowering Spray of Cotton
3 Boll
4 Seed with Lint
5 Seeds
6 Ginnery
7 Export Bale of Cotton
8 Spinning Frame
9 Weft Yarn
10 Warp Yarn
11 Loom
12 Shirting
13 The finished Shirt
14
SEA ISLAND
also PYJAMAS, RAINCOATS, TROPICAL UNDERCLOTHING, HOSE & HANDKERCHIEFS.

5. *Cotton Seed.*—The seeds themselves, rather smaller than a garden pea, are black in colour and have a hard hull or skin with a small tuft of greenish "fuzz" at the pointed end. They yield by expression an oil (the cotton-seed oil of commerce) which after refining is extensively used as a cooking oil, and in the manufacture of margarine, while the crude oil and the residues from refining are employed in the manufacture of soap. In the West Indies, however, the seeds are used mainly for planting the next season's crop, for feeding livestock or, in a crushed form, as a manure. The cake, which remains after expression of the oil, is widely used for cattle-food.

6. *Ginnery.*—The next step is the separation of the cotton hairs from the seed. This is known as ginning, and the factories are called ginneries. Here the seed-cotton is first dried and sorted and then fed to machines (gins), each of which consists essentially of a revolving leather roller, which grips the lint against a metal plate, while an oscillating knife beats away the seeds. Each pound of seed-cotton yields about ¼ lb. of cotton lint and ¾ lb. of cotton seed.

7. *Cotton Bale.*—The cotton lint is conveyed to the baling room and there compressed into bales, covered with gunny cloth and bound with four iron bands, each bale weighing about 400 lb. On arrival at a cotton mill in England such a bale of compressed cotton has to undergo a sequence of processes before the cotton can be spun into yarn. These processes include opening the bale and cleaning the cotton; scutching, carding, combing, drafting and doubling; and then the drawing and twisting operations. The result is the breaking down of the tightly compressed mass of baled cotton; the cleaning of the fluffy mass of lint; the arranging of the individual fibres more or less parallel with each other; their conversion into a thick loose rope of "slubbing"; and finally the drawing out of the slubbings into a thinner more compact strand of "roving."

8. *Spinning Frame.*—Spinning is the final stage in the manufacture of cotton yarn. In the spinning frame the roving is further drawn out and given its final twist, interlocking the fibres and converting the weak roving into a strong, even strand of finished yarn. There are two types of spinning frames, the "mule" and the "ring," but the "mule" gives to Sea Island cotton a softer and more even yarn. From the finest Sea Island cotton it is possible to spin a yarn so fine that 190 miles of it weigh only 1 lb.

9. *Shuttle of weft yarn.*—A simple woven fabric consists essentially of two sets of yarns, the warp and the weft, interlaced at right-angles to each other. Weft yarns traverse the width of the fabric and are shot into position by means of a shuttle. They have to stand little strain and need not be so level, strong and compact as those which run the length of the fabric (the warp yarns).

10. *Bobbin of warp yarn.*—The warp yarns run the whole length of the fabric (which may be 20,000 yds. long). They have to take

the main strain of the finished fabric as well as the stresses of sizing, weaving and finishing, and must therefore be stronger than the weft yarns.

11. *The Loom.*—In the loom, the warp and weft yarns are interlaced to form the finished fabric. In its simplest form, a loom consists of a cylinder (the beam) on which are wrapped, in parallel order, a series of warp yarns, the ends of which are attached to the cloth roll at the front. Between these two are a pair of harnesses (generally known as healds and reeds) which are threaded with alternate warp threads. The movements of the harnesses alternately up and down form a " shed " through which the shuttle is successively passed, paying out weft thread as it goes. After each shot of the shuttle through the shed, and as the healds and reeds are changing position, the weft yarn is pressed back into place against the edge of the fabric already made. The five principal motions in a loom are thus :

(*a*) Letting off the warp yarn from the beam.
(*b*) Opening a shed by lifting up certain warp threads and forcing down others to allow the shuttle to pass through.
(*c*) The throwing of the shuttle between the two sets of warp yarns, leaving a line of weft yarn in its track.
(*d*) The beating in of each line of weft up to the line preceding it.
(*e*) The taking up of the made fabric on the cloth roll.

12, 13. *Shirtings, etc.*—The soft silky finish of Sea Island fabrics makes them eminently suitable for shirtings. The stripes so popular in this material are obtained by arranging a series of coloured warp threads among the white ones in preparing the beam. Other articles of intimate apparel for which Sea Island cotton is particularly favoured are pyjamas, raincoats, underclothing, hosiery and handkerchiefs.

14. *Barrage Balloons.*—The strength and closeness of weave possible with Sea Island cotton have found special application in the fabric used in the manufacture of the now all too familiar barrage balloons.

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Scientific names and titles of books are printed in italics and personal names in capitals